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IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant(s): CHRISTENSEN, Carlos M. et al.

Application No.: Group:

Filed: April 25, 2001 Examiner:

For: RF HOME AUTOMATION SYSTEM COMPRISING REPLICABLE CONTROLLERS

LETTER

Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

April 25, 2001
0459-0596P

Sir:

Under the provisions of 35 USC 119 and 37 CFR 1.55(a), the applicant hereby claims the right of priority based on the following application(s):

Country	Application No.	Filed
UNITED STATES OF AMERICA	09/547,055	04/10/00

A certified copy of the above-noted application(s) is(are) attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. 1.16 or under 37 C.F.R. 1.17; particularly, extension of time fees.

Respectfully submitted,

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1 of 1

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U.S. PTO 09/840827 04/25/01

THE UNITED STATES OF AMERICA

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UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

March 20, 2001

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APPLICATION NUMBER: ***09/547,055***
FILING DATE: ***April 10, 2000***

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Date: April 10, 2000
Docket No.: 0459-0425P

Assistant Commissioner for Patents
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Sir:

Transmitted herewith for filing is the patent application of

Inventor(s): KNUDSEN, Jesper
CHRISTENSEN, Carlos M.

For: RF HOME AUTOMATION SYSTEM

Enclosed are:

X A specification consisting of 66 pages

X 14 sheet(s) of Formal drawings

X An assignment of the invention

\ Certified copy of Priority Document(s)

X Executed Declaration X Original ___ Photocopy

___ A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27

___ Preliminary Amendment

X Information Disclosure Statement, PTO-1449 and reference(s)

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___ Other ______________________________

The filing fee has been calculated as shown below:

FOR	NO. FILED	NO. EXTRA	LARGE ENTITY RATE	LARGE ENTITY FEE		SMALL ENTITY RATE	SMALL ENTITY FEE
BASIC FEE	*********** *********** ***********	********** ********** **********	***** ***** *****	$690.00	or	**** **** ****	$345.00
TOTAL CLAIMS	77 - 20 =	57	x18 =	$1,026.00	or	x 9 =	$ 0.00
INDEPENDENT	5 - 3 =	2	x78 =	$ 156.00	or	x 39 =	$ 0.00
MULTIPLE DEPENDENT CLAIM PRESENTED	no		+260 =	$ 0.00	or	+130 =	$ 0.00
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Respectfully submitted,

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RF HOME AUTOMATION SYSTEM

BACKGROUND OF THE INVENTION

Home automation systems for controlling various functions such as lighting and audio equipment has been a traditional "inventors field" for many years. Many of the systems have been specifically designed for lighting control such as EP 923,060 described below whereas others have been integrated in remote controlled audio equipment.

EP 923,060 discloses a system for controlling lighting in a building using a minimum of wire connections. Typically there is a conducting wire from the building's source of electricity to the contact and again from the contact to the lamp. The disclosed system proposes a system where the lamp is directly connected to the building's source of electricity, but through an inaccessible remotely controlled contact. Instead of a wall-contact, the disclosed system provides a battery driven "remote control" fixed in the wall, for turning the lamp on/off in typical fashion by controlling the status of the remotely controlled contact in the lamp wiring. The system uses radio frequency communication.

In recent years, work has been done for extending the functionality of home automation systems towards a "smart-home" concept, where many different electrical units are remotely controlled in a joint system. Wireless radio frequency (RF) communication has become the prevailing method for the network communication in such systems since most building elements and furniture transmits RF radiation with very little attenuation.

Home automation systems at their present stage are typically limited to control, i.e. turning on/off and dimming, the power supply to electrical devises in response to the user's command on a centralized control unit. Systems for controlling the power supply to electrical devises from centralized control units exist in a variety of forms and levels of complexity, e.g. US 5,905,442.

US 5,905,442 discloses a system with a centralized remote control which controls system devices providing power to electrical appliances from power outlets of the power grid or mains in the building. The remote control is itself powered by the power grid. The remote control and system devices comprise RF transceivers, and the system includes repeater

units for repeating signals from remote control devices out of range. In order to configure the system all devices have to be installed, see e.g. Col. 18, Line 27 - Col. 19, Line 54, and addressed, see e.g. Col. 19, Line 59 - Col. 21, Line 40 or Col. 20, Line 53 - Col. 21, Line 5). There is a two-way communication between the remote controls and the system device so that one can determine the status of a given device, Col. 21, Line 52 - 60. The programming of the system is very complicated and unpractical since in order to program a single device, all devices in the whole system will be turned on and off, see Col. 22, Line 9 - 31.

The European patent application EP 782,117 discloses a system for controlling electrical appliances. The system comprises interface units with device drivers for controlling the electrical appliance connected thereto, such as a VCR or a TV set. The control unit is typically a personal computer, which controls the functions of the appliances through the interface units and drivers. There is a radio frequency link in both the interface unit and the control unit.

It is a disadvantage of the existing automation systems that they do not disclose a system, which is easy to configure and to expand, even when including more than one controller.

It is another disadvantage of existing automation systems that they do not disclose a system that provides fault tolerance or user feed-back in case of malfunction in combination with radio frequency based control of appliances and equipment.

It is another disadvantage of existing automation systems that they do not disclose a system that is operational without the use of dedicated repeaters regardless of the systems topology, i.e. even when controlling devices physically located beyond the direct reach of the controller(s).

It is further a disadvantage of the existing automation systems that they do not disclose a system in which it is possible to perform all of the following: a) directly (manually) to control an appliance, b) program the system to perform certain time- or event-triggered actions or routines, c) program individual devices to enter into pre-defined operational states when prompted to, either automatically or manually, and d) sense or monitor physical parameters.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an automation system for controlling and monitoring equipment and appliances, comprising an overall architecture and programming which allows for easy configuration and expandability even when including more than one controller.

It is another object of the present invention to provide an automation system that utilizes radio frequency as means of transmitting control, monitoring and other information carrying signals thereby providing flexibility in terms of the physical placement of controllers and controlled devices yet providing fault tolerance or user feed-back in case of malfunction.

It is still another object of the of the present invention to provide an automation system that is flexible to a dynamically changing topology, in that the system allows for physical expansion, without the use of dedicated repeaters, beyond the direct transmission range of any of the transmitting units, be it a control unit or a controlled or monitored appliance, even if the units are mobile units, such as a remote control.

It is further an object of the present invention to provide an automation system that is automatically configured with a unique identity code when it is first installed thereby allowing for transmission range overlap with neighboring systems without interference.

It is further an object of the present invention to provide an automation system that comprises very broad functionality in that it allows for:

a) direct (manual) control of appliances,
b) programming of the system to perform certain time- or event-triggered actions or routines,
c) programming individual appliances and equipment to enter into pre-defined operational states when prompted to, either automatically or manually,
d) sensing or monitoring physical parameters.

In order to achieve these objects and in order to approach the "smart home", each device must be an intelligent unit in a large network covering the whole building. The infrastructure of the network must be self-administrating in order to take into account

addition and removal of devices as well as devices and controllers that change location. This invention provides an automation system wherein controllers as well as controlled devices are unique in that they are characterized by unique identifiers. Thereby any number of systems can physically overlap without interference. Moreover, this invention provides a system comprising automatic configuration of any of the controlled devices to expand their functionality to include that of a repeater thereby repeating signals as needed for any device out of the reach for the transmitting device or controller. Moreover, this invention provides a system in which more than one controller can exist in that the system provides for a method according to which controllers can share information with each other. Moreover, this invention provides a system in which devices can sense or monitor one or more parameters and save or transmit the parameters to other units in the system.

The present automation system is unique in that it is characterized by a unique identifier, which is used in all communication within the system. Each system further comprises a plurality of devices being addressed by a unique identifier so that no two devices are addressed identically. Thereby the setup and addressing of any device in any system can easily be performed by giving its unique identifier.

In a first aspect, the invention provides an automation system for remote controlling and monitoring of devices, the system comprises a first controller to be operated by the user of the system, the first controller comprising:

a transmitter for transmitting signals,
a receiver for receiving signals,
a first memory holding a unique first identifier,
a second memory adapted to hold a device identifier, and
a first processor adapted to store one or more device identifiers in the second memory.

The user can by operating the controller, control at least a first device controlled by the first controller, said first device comprising:

a transmitter for transmitting signals,
a receiver for receiving signals,

a first memory adapted to hold the device identifier identifying the first device,
a second memory adapted to hold the unique first identifier, and
a first processor adapted to (receive and) store the unique first identifier in the second memory,

wherein the first device is adapted to respond only to signals comprising the first unique identifier.

Hence devices can only be controlled by controllers using the first unique identifier, and thereby interference with other system is avoided.

In the present specification and claims, the term "processor" designates any conventional or proprietary processor or microprocessor such as a hardwired proprietary processor or finite state machine, Read Only Memory (ROM) or software programmable microprocessor as well as combinations thereof capable of providing the required management of received and transmitted data.

The term "memory" designates one or several memory areas adapted to store digital information. Preferably, it is possible to read, write and delete data in the memory. The memory might be allocated in a larger memory structure comprising several memories utilized by a processor for e.g. application program storage and/or data storage.

The term "signal" designates a conveyor of information, such as an electromagnetic wave or a series of pulses. Preferably, the signal is formed by a modulation of a carrier waveform and recovered during reception by demodulation. The modulations may be digital modulations so as to convey digital information. The information in a signal according to the present invention is preferably comprised in a digital communication frame, which comprises a number of bits identifying the frame and a number of bits conveying the transmitted information or data.

An identifier is a data string identifying a unit or an element, such as a device or a part of a device or a data structure such as a table or designated memory area, and may be a name, a code or a number designating the unit or element.

Device identifiers are data strings identifying the individual devices as single, specific devices within a network of devices. Device identifiers are preferably used to designate the specific device in the addressing of devices in communication within a network of devices. Preferably, the device identifiers are used to designate the specific device within a communication protocol, which is an agreed set of operational procedures to enable data to be transferred between devices.

A unique identifier is a data string identifying a single, specific device wherein the data string is not identical to any data string used to identify any other specific device globally. Identifiers may comprise several parts, each of which is individual identifiers and denoted as such. Such identifiers may comprise a first part, which is the unique identifier of another device, and a second part, which identifies the specific device in relation to the other device. Thereby, such two-part identifiers may establish a subsystem of unique identifiers under the unique identifier for the other device.

The unique identifier of the first controller is preferably set during fabrication of the controller, and the processor of the first controller is adapted to generate at least part of the devices identifier when the device is implemented in the system. Optionally, the device identifier identifying the first device comprises a first and a second part, wherein the first part is the unique first identifier and the second part is specific for the first device within the system. Hence, the device identifier identifying the first device may be unique. Preferably, all identifiers are in the form of binary identification strings.

Preferably, the transmitters of the controllers and the devices in the system are radio frequency transmitters and the receivers are radio frequency receivers.

Devices and controllers within a system must be able to communicate in order to provide an extensive and functional control of all devices in the system. Thus, devices and controllers in the system are preferably adapted to generate signals comprising the unique first identifier. Furthermore, the devices are adapted to generate and transmit signals comprising data to the controllers, and the controllers are adapted to generate and transmit signals comprising data to the devices. In order for a signal to be transmitted to a device or a controller, the signal may further comprise the identifier of the device or the controller.

Since identifiers may be stored differently within a controller or a device, the first and the second memory may be the same memory. Also, the processors of the controllers and devices in the system may comprise means for compressing data to be transmitted in a signal. Optionally, the processors further comprise encryption means for encrypting data to be transmitted in a signal.

The second memory of the controllers may comprise one or more data tables adapted to hold the device identifiers of devices to be controlled by the each controller. This provides means for the controllers to administer the device identifiers, since the device identifiers can be systematically ordered, grouped and designated. Further, the second memory of the first controller may comprise alphanumerical strings held in relation to a data table and the entries of the data table. Optionally, a data table further comprises one or more predetermined settings held in relation to the device identifiers and characterizing the operational state of the corresponding devices. Such settings may be predetermined and used to select a predetermined operation of one or more devices.

Preferably, the first processor of a controller is further adapted to generate signals comprising at least one device identifier and at least one predetermined setting held in relation to said device identifier. Also, the first processor is adapted to generate a signal comprising commands for devices and addressing the signal to one or more devices.

A command is a code, word or phrase conveyed to a device to which the device responds. The command may comprise instructions of how to respond. A respond is any action carried out by the device and initiated by the reception of the command.

Optionally, signals comprising commands for devices may be addressed to all devices without addressing each device individually, instead a general designation to which all signals are adapted to respond is used. Such signals are referred to as broadcast signals. For this reason, the devices further comprise a status setting for determining whether the device should respond to commands in a broadcast signal addressed to all devices.

The system may comprise a second controller comprising:

a radio frequency transmitter for transmitting signals,

a radio frequency receiver for receiving signals,

a first memory holding a unique first identifier,
a second memory adapted to hold a device identifier, and
a third memory adapted to hold the unique first identifier of the first controller,
a first processor adapted to store one or more device identifiers in the second memory.

Preferably, such second controller forms part of the system and is adapted to respond only to signals comprising the first unique identifier.

The second controller is equivalent to the first controller except for at different organization of the memory. Since the controllers hold information relating to the system, tables with device identifiers of devices in the system etc., it is useful to be able to share information between controllers by learning a controller information held by another controller.

In order for the second controller to respond only to signals comprising the first unique identifier, the second controller must first learn the first unique identifier.

Therefore:

the first processor of the first controller is preferably adapted to generate a signal comprising the first unique identifier, and

the first processor of the second controller is preferably adapted to receive said signal from the receiver and store said first unique identifier in the third memory of the second controller.

The system preferably also provides the possibility for sharing information related to devices in the system between controllers in that:

the first processor of the first controller is further adapted to generate a signal comprising a first device identifier of a device controlled by the first controller, and

the first processor of the second controller is further adapted to receive said signal from the receiver and store said first device identifier in the second memory of the second controller.

The information may be information such as data tables of the first controller, alphanumerical strings, one or more predetermined setting of devices in the system, etc.

The first device of the system according to the present invention may be an output device in that it is adapted to generate an output. Preferably, the output generated by the first device is adjusted in response to a received signal, such as a signal transmitted from a controller. Thus, by controlling the first device, the user can control the output given by the first device.

Preferably, the device is adapted to generate and transmit a signal in response to a received signal so as to reply to the received signal, e.g. with an acknowledgement of receiving the signal or with a status of the device. Also, the device may generate and transmit a signal by it own motion, e.g. in response to a signal from its own processor.

Optionally, the output is a signal to an appliance operationally connected to the first device, and wherein said signal comprises one or more instructions related to the operational state of the appliance. Thereby the user may control the operation of the appliance by controlling the signal given by the first device. Hence the user may operate the appliance remotely.

In a preferred embodiment, the output from the first device is electric power in the form of electric current or an electric potential. In this case, the first device may adjust the output power to a level corresponding to a setting comprised in a received signal, that is, the user may turn the output on or off or adjust the output level to any desired power.

In another preferred embodiment, the user can restrict the operation and hence the output from the first device, and protect this restriction by a code. Thereby, the user can prohibit other users from changing the operational state of the device. The term restriction is to be interpreted as any fixed operational state of the device. This may be e.g. an "off" state where the device provides no output, a state where the device provides a certain type of output such as a certain signal to an appliance connected to the output, a state where the

output is allowed to be adjusted only within a predetermined range or within a predetermined time or both, a state where the output is adjusted according to a predetermined program, etc.

In this case, the first device restricts the output in response to a received first set of instructions, and the restriction may only be removed in response to a received second set of instructions. Also, the first controller is adapted to generate the second set of instructions only when provided with the predetermined code, password or alike.

In another preferred embodiment, the first device is adapted to receive input. Preferably, the processor of the first device operationally connected to a sensor, and the sensor, upon sensing a signal, forms a signal, which is received by the processor as input. Preferably the signal from the sensor is an electric signal.

The processor may process the received input, e.g. store the input in the second memory of the first device, generated and transmit a signal comprising the input, store the input in the second memory of the first device and at a later time generate and transmit a signal comprising the input, generate and transmit a signal in response to the received input, etc.

The first sensor may be any sensor selected from the group consisting of electromagnetic radiation sensor, luminosity sensor, moisture sensor, movement sensor, temperature sensor, mechanical actuator contact, sound sensor, pressure sensor, electric signal sensor, smoke detector, audio pattern recognizing means, visual pattern recognizing means, molecular composition analyzing means and more as well as any combinations thereof.

In a preferred embodiment, the sensor measures the impedance of an electric signal, such as the capacitance, the resistance or the inductance.

In order to reach devices or controllers outside the signal range of a transmitter, one or mode devices may be adapted to act as repeaters. The signal range of a transmitter is the physical range within which a device or a controller will receive a signal addressed for that device or controller when the signal is transmitted from the transmitter. When receiving a signal carrying information, a repeater will transmit a signal carrying at least some of the information also carried by the received signal. Thereby devices or controllers within the

signal range of the repeater, but outside the signal range of the original transmitter, can receive the signal transmitted by the repeater.

Preferably all devices in a system are adapted to act as repeaters. In this case, the system is preferably adapted to designate devices to be repeaters in order to ensure that all devices within a system can be reached. In a preferred embodiment, each controller comprises a program for systematically designating device to act as repeaters. Such a program is described in relation to Figures 4 through 12. Optionally, the program also builds a data table comprising the identifiers of the devices designated as repeaters and the identifiers of at least some of the devices, which are within the signal range of each repeater. Alternatively, the program builds a data table comprising the identifiers of all devices controlled by the first controller, and the identifier of the one or more repeaters, which must be used in order to reach each device.

The system according to the present invention preferably comprises a protocol. A protocol is any set of operational procedures, which enable data such as identifiers, settings and frames and any data comprised in a frame as well as stored data to be transferred and administered within the system. Preferably, it is the protocol in the transmitting part which generates frames for transmitting a signal, including designating the system, the transmitter and the receiver by their identifiers in the frame. Also, the protocol includes the commands, information or data transferred by the frame. Likewise, it is preferably the protocol in the receiving part, which reads the received frame and enables the receiving part to respond to the signal.

In order to reduce the amount of data transferred in each frame, the system protocol preferably comprises operational procedures for applying a masking procedure to the identifiers of the devices addressed by a given frame. The making procedure is an operation that builds a register with each entry corresponding to a device, and where the value of each entry indicates whether the corresponding devices should respond to a command in the frame or not. Instead of including all the identifiers for the devices that should respond to a command in a frame one includes the masking register, whereby a shorthand designation of devices is achieved. Thus, the system protocol comprises operational procedures for generating a first type of frame comprising one or more commands. The protocol comprising a procedure of masking a first group of device identifiers in a table of a controller in order to generate a string of bits forming part of the

frame, so that each bit corresponds to a device identifier and a device of the first group, the value of each bit determining whether the one or more commands applies to the corresponding device.

Similarly, the system protocol preferably comprises operational procedures for applying a masking procedure to the commands issued in a frame. Typically a considerable amount of the commands, status messages, information, data etc. distributed in the system is standard instructions. Hence the devices may already know these and the data transmission can be reduced by applying a masking procedure to these different types of standard instructions. Thus, the system protocol preferably comprises operational procedures adapted to generate and transmit a frame of a second type comprising two or more instructions from a second table of instructions comprised in the memory of a controller. The protocol comprises a procedure of masking a first group of instructions in the table of the controller in order to generate a string of bits forming part of the frame, so that each bit corresponds to an instruction of the first group, the value of said bit determining whether the one or more corresponding instructions applies to devices receiving the frame.

When the system is adapted to perform a specified function, the protocol will often, but not always, comprise one or more operational procedures for performing the specified function.

In a second aspect, the invention relates to a device in a two ways communication automation system, where the device is coupled to an electrical appliance for providing power to the electrical appliance. Moreover, the device comprises means for measuring the power supplied to the electrical appliance by the device. Thereby, the operation of the appliance can be remotely controlled and the power consumption of the appliance can be remotely monitored. Preferably, the device is adapted to be used in a system according to the first aspect of the invention.

In a preferred embodiment, the device comprises

a transmitter for transmitting signals,
a receiver for and receiving signals,

means for adjusting the power supplied to the electrical appliance in response to a received signal,

means for measuring the power supplied to the electrical appliance, said measuring means giving an output signal, and

a processor operationally connected to the output of the measuring means, said processor being adapted to generate a signal comprising information relating to the output signal of the measuring means.

Preferably, the power measuring means measures the power supplied to the electrical appliance by measuring the current supplied to the electrical appliance. Optionally the device further comprises an analogue to digital converter operationally connected between the output of the measuring means and the processor.

The processor of the device is typically adapted to process output of the measuring means, e.g. store information relating to the output on a memory of the device, store the output in the memory over a time period so as to monitor the power consumption of the electrical appliance, generate and transmit a signal comprising information from the memory, perform mathematical operations on the output from the first measuring means, etc.

In a third aspect, the invention relates to a device in a two ways communication automation system, where the device is coupled to two or more electrical appliances for providing power to the electrical appliances. Moreover, the device is adapted to control the power supplied to the two or more appliances individually in response to received signals. Thereby it is possible to have a number of appliances connected to and controlled by a single device, hence reducing the complexity of controlling a number of appliances. Preferably, the device is adapted to be used in a system according to the first aspect of the invention.

In a preferred embodiment, the device comprises

a receiver for receiving signals,

a transmitter for transmitting signals,

a memory adapted to store at least a first and a second identifier,

a power inlet,

two or more power outputs from the device, and
processor means for handling received signals and operationally connected to means for adjusting the power supplied by the two or more power outputs,

wherein the first and second identifier relates to a first and second outlet in that the power supplied by the first power output is adjusted in response to a received signal comprising the first identifier, and the power supplied by the second power output is adjusted in response to a received signal comprising the second identifier.

Optionally, the device comprises memories and/or processors according to the number of outputs, each memory being dedicated to an output by holding the identifier related to the output, and each processor being dedicated to an output by being adapted to handle signals comprising an identifier related to the output.

A fourth aspect of the invention relates to a method for operating an automation system according to the first aspect of the invention.

In the simplest approach, the method relates to sending a signal from a first controller to a first device, and comprises the step of transmitting a first signal from the first controller, the first signal comprising the unique first identifier of the system and the identifier of the first device.

In another approach, the method relates to implementing new devices in the system. The implementation comprises among other things that an identifier must be assigned to the new device. Thus, this method further comprises the step of receiving the first signal at the first device, and storing the identifier of the first device and the unique first identifier of the first controller in the memory of the first device. Optionally, the first device may be prepared for implementation in the system by activating the device by activating an actuator operationally connected to the processor of the device. Also, the implementation may comprise storing the newly assigned identifier of the first device in one or more data tables of the first controller.

In another approach, the method relates to the establishment and control of a group of identifiers in the memory of a controller. Thereby the devices in the group can be controlled collectively by controlling the group of devices instead of each device

individually. The method preferably comprises the step of storing a group of device identifiers in the memory of the controller and storing in relation thereto a group identifier for collectively designating the device identifiers in the group. Further, the method may comprise controlling the devices in the group by selecting a command on the controller, selecting a group on the controller, and generating, in response to these selections, a signal comprising the command, the first unique identifier of the system and the group of device identifiers designated by the group identifier of the selected group. Optionally, the masking procedure described in relation to the first aspect may advantageously be used to address the devices in the signal.

In still another approach, the method relates to the establishment and control of a mood. A mood is a predetermined setting of a predetermined set of devices which, when effected, creates a situation characterized by the operation of the predetermined set of devices. If e.g. the devices are lamps and the settings relates to the luminosity of the light, the mood will be a specific illumination. Thus, the operation of each device can be characterized by two or more different settings, and the method further comprises the steps of storing one or more device identifiers and/or one or more group identifiers in the memory of the controller and storing in relation to each identifier a setting characterizing the operation of the device or group of devices. Also, a mood identifier for designating said identifiers and said settings is stored in relation to the identifiers and setting. Further, the method may comprise controlling the devices in the group by selecting a mood on the controller and generating, in response to the selection, a signal comprising the first unique identifier of the system, the device identifiers and their related settings, and the device identifiers designated by the groups and their related settings, all as designated by the selected mood. Optionally, the masking procedure described in relation to the first aspect may advantageously be used to address the devices in the signal.

In a fifth aspect, the invention relates to a method for changing the status of one or more devices in an automation system according to the first aspect.

According to the fifth aspect, the devices have two or more states characterizing their operation, and the processor of each device comprises a setting determining whether the device should change its state in response to a signal from the controller comprising a command for changing the state of the device.

Thus the method comprises the steps of:

generating in the controller a signal addressing one or more devices and comprising one or more commands for changing the state of the devices,

transmitting the signal,

receiving the signal at each of the devices, and

if the setting in a device determines that the device should change its state in response to the signal, then changing the state of the device according to the signal, and

if the setting determines that a device should not change its state in response to the signal, then no change in the state of the device.

Optionally, the signals used in the fifth aspect are broadcast signals as defined in relation to the system of the first aspect. In this case, the setting in the processors of the devices determines whether or not the device should respond to commands in a broadcast signal. Alternatively, the first signal is addressing a randomly chosen selection of the devices controlled by the first controller. The masking procedure described in relation to the first aspect may advantageously be used to address the devices in the signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates an implementation of a system according to an embodiment of the present invention.

Figure 2 is two diagrams illustrating the addressing of signals according to an embodiment of the present invention.

Figure 3 is a flow diagram illustrating transmitting and acknowledgement of a command according to a first preferred embodiment of the present invention.

Figures 4 through 12 shows an example of a topology map of a system network, the figures illustrate an automated repeater detection process according to the first embodiment of the present invention.

Figure 13 through 18 shows a system network with repeaters, the figures illustrates the preferred communication procedure for small capacity controllers according to the first embodiment of the present invention.

Figure 19 shows a controller according to a second embodiment of the invention.

Figure 20 is a flow diagram showing the procedure for removing a device from a group on the controller according to the second embodiment of the present invention.

Figure 21 is a flow diagram showing the procedure for creating a mood on the controller according to the second embodiment of the present invention.

Figure 22 is a flow diagram showing the procedure for learning of a controller according to the second embodiment of the present invention.

Figure 23 shows an example of a diagram of an electrical circuit for measuring the power supplied by a device according to the second preferred embodiment of the present invention.

Figure 24 shows a multiple outlet according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to an automation system in which a two-way communication is performed within a network. The automation system can perform certain functions for the user of the system and comprises one or more controllers for controlling one or more devices performing the functions. Hence, the system comprises a network of devices for performing functions all controlled by the controllers operated by the user.

A controller allows the user to control the devices and the functions performed by the devices. The controller can be a computer (PC, notebook, handheld etc.), a remote control, a mobile phone, a WAP (Wireless Application Protocol) device or any other controlling device adapted to communicate with a device. The communication between controllers and devices is preferably carried out via radio frequency modulated data transmission.

Figure 1 shows a possible implementation of the system according to an embodiment of the present invention. Figure 1 shows a ground plan of a house 18 with several rooms. The house has an inlaid electricity grid consisting of conducting wires 40 (thick lines) leading to a number of electricity outlets 19 (gray squares). This compares to the electricity net for a typical building. A number of different electric appliances connected to electricity outlets are positioned around the house, these are lamps 11, TV set 12, shaver 13, toaster 14, and thermostat 15 for radiator. Each appliance is connected to a device 41, which can be remotely controlled by a controller 17 through RF signals 16.

The devices 41 can be connected between the appliance and the electricity outlet 19 such as in the case of the toaster 14, or be an integrated part of the appliances as in the case of the TV set 12. Thereby controlling the device connected thereto can control the power supply to and/or the function of an appliance. Examples of this controlling is turning the lamps 11 on/off, change the operation status such as the channel of the TV set, setting another temperature on the thermostat 15 or activating the burglar alarm 39. Also, a device can report to the controller with a status of an appliance, such as the temperature in the room of the thermostat 15 or the status of the alarm 39.

According to an embodiment of the present invention, the system comprises a communication protocol providing a simple addressing of devices and controllers. First, the controllers and devices in a building are combined into a unique logical system characterized by a unique identifier comprised in all communication signals within the system. The controllers and the devices in the system are also characterized and addressed by identifiers, and Figure 2 shows two examples, 42 and 43, of addressing of a signal in a system according to the present invention.

Preferably, the addressing of a signal for a controller or a device first designates the system in which signal is used, hence the "system" part of 42. Further, the addressing

designates the transmitting part and the receiving part or parts as illustrated in 42. In a specific example illustrated by 43, the transmitter is a controller and the receiver is a device.

Thereby a system does not interfere with a neighboring system since controllers and devices in the respective systems respond only to signals comprising the unique system identifier of the respective systems. The system identifier will be called the Home ID in the following.

Preferably, each controller has a pre-set unique identifier. The controller identifiers are stored in the controllers from factory and cannot be altered. This ensures the uniqueness of the controller identifiers. Alternatively, the identifiers can be assigned to non-volatile storage in the controller from an online service provider such as through the Internet.

In a preferred embodiment, the unique Home ID is the identifier of the first controller utilized in a system and is assigned to the system when the system is set up. Since the controller identifier is unique, so is the assigned Home ID. It is an advantage that the system in this preferred embodiment inherently has a unique Home ID, thereby the user does not have to specify a Home ID when setting up the system. This greatly simplifies the functionality of the system.

Since a device is always addressed together with the designation of the system, the device identifier are preferably an extension to the Home ID of the system, the extension identifying the device within the system. The device identifiers, hereafter Device ID's, are preferably assigned to the devices by the controller when a device is incorporated in the system for the first time. The device identifier is stored in the controller and in the device itself. In order to minimize the use of frame space and also to reduce storage on the controller, the device identifiers identifying the devices has to be kept as small as possible. Alternatively, the Device ID's are also stored from factory and simply provided to the controller when the device is set up. Hence a device can be addressed non-uniquely by giving only its extension, or it can be addressed uniquely by giving its Home ID plus its extension.

All controllers and devices preferably comprise at least parts of a common protocol for transferring and administering data within the system. The protocol are preferably a

software protocol, optionally, parts of the protocol comprises hardwired units such as integrated circuits and microprocessors. The protocol administers identifiers and manages the addressing of frames for communication within the system.

In a first preferred embodiment, the Device ID's are an 8bit value, which is only unique within a specific system. As mentioned in the above, the Device ID is always used in relation to a Home ID in a frame in the communication protocol, thereby preserving the all-over uniqueness of a device. The size of the controller identifier, and thereby of the Home ID, has to have such a size that we would never run out of unique addresses. The controller identifier is therefore a 32bit value giving up to 4294967295 unique Home ID's.

The communication protocol designed to overcome the usual problems seen in radio communication applications. The most common problem is noise, which can cause the data communicated between two devices to be lost or corrupted. The error rate of which data is corrupted is specified in amount of error bits per transferred data stream (bit error rate). The general rule is that the less data being transferred the bigger chance there is for a successful transfer.

In the prior art, the size of the frame format holding the data to be sent is not of very high importance, since it typically takes up a very small part of the total amount of data bits. However, in the present invention where the system is used to send short commands and instructions, the frame format often makes up a considerable amount of the data bits to be sent. Therefore, the general format of the frames used in the communication protocol of a preferred embodiment of the present invention, is designed to reduce the amount of data, i.e. to obtain a short frame, is to be able to send commands to more than one device in one single frame and to address these devices in a concise notation. Similarly, the commands comprised in the frame should also be minimized. The protocol designed for the present invention take these considerations into account in that it provides masking of device identifiers and commands as well as compression of data.

In order to perform the functions stated so far, controllers and devices both comprise certain elements, namely:

Controller:

An RF transmitter and an RF receiver

Memory holding the controller identifier and the Home ID
Memory holding Device ID's of devices controlled by the controller
A processor for performing the storage and administration of information and for generating and processing the communication frames.

Devices:

An RF transmitter and an RF receiver
Memory holding the Device ID of the device
Memory holding the Home ID
A processor for performing the storage and administration of information and for processing and generating the communication frames.

Preferably the processor means of controllers also administers the communication protocol.

The devices to be controlled may perform several functions, which can be divided into types of functions:

- Output; to provide an output such as a command, an instruction, a message or electrical power to an electric appliance connected thereto, e.g. a coffee machine, an oven, a surveillance system, a door lock, audio equipment etc. In the embodiment illustrated in Figure 1, devices connected to lamps 11 and the toaster 14 provide an output in the form of electrical power, the device connected to the TV set 12 provides instructions for operating the TV set, and optionally also electrical power.
- Input; to receive an input from an appliance such as a sensor or an input unit such as a keyboard or a pointing device connected thereto and store, process and/or transmit the input. In the embodiment illustrated in Figure 1, the thermostat devices 15 receives an input from a thermometer for monitoring the room temperature, and the alarm device 39 also receive an input from a sensor in case of burglary. The controllers of the system can be programmed to respond to a signal from a device receiving input, e.g. activating a sound signal and calling security in case of a detected burglary.
- Repeating; for repeating signals from a controller or from a device in order to reach devices outside the signal range of the transmitting device.

A device can be separated unit which is connected to the appliance as the devices controlling lamps 11 in Figure 1, or a device can be an integrated part of the appliance as is the case for the device in the TV set 12. A device can perform a function itself or it can permit, instruct or make capable an appliance connected to the device to perform a function. Devices are preferably adapted to perform one or more types of functions.

The user interface of a controller allows the user to control each device controlled by the controller. The devices controlled by the controller can be ordered in different output classes so that two or more devices can be controlled together, e.g. the temperature of all thermostats 15 in a house, see Figure 1, can be regulated simultaneously. Such output classes are preferably characterized by a set of variables such as:

Output Class	Characteristic Variables	Comments
Output device	Device ID	Consists of a device
Groups	Group ID Device ID	Consists of several devices
Moods	Mood ID Group ID's Device ID's Settings	Consists of several devices and/or groups and an individual pre-set setting for each device or group of devices.

Groups are an output class consisting of several devices. This output class is utilized for controlling multiple output devices with one single command. Moods are essentially "groups of groups" and "groups of devices" in which each device and group has specific settings characterizing the operation of the devices and groups. In the embodiment described in relation to Figure 1, a mood can comprise all devices connected to lamps 11 in the living room and the settings could be the amount of power supplied to the lamp by each device. By selecting this mood, all lamps in the living room would be dimmed to a predetermined level creating desired lighting. In another example, the mood comprises all thermostats 15 in the house and the settings are the desired room temperatures in each room. Hence by selecting the mood, a predetermined temperature setup can be set around the house. The settings of devices or groups depend on the function performed by each device and are set

individually for devices and groups. One device may belong to one or more groups and each Group may belong to one or more moods.

The communication protocol of the first embodiment has a general format for the frames carrying the instructions and information between the devices of the system.

The frame format according to the first embodiment can be described as:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Home ID (Low word)															
Home ID (High word)															
Source Device ID (Low word)															
Source Device ID (High word)															
Version			Dir.	Type								Length (bytes, ex. Checksum)			
Data byte n												Data byte 0			
												Checksum			

Table 1

Wherein:

- The numbers 0 through 15 represent a bit-scale giving the order and sizes of each part of the frame. The order in which the parts appear are not restrictive and different orders can be used.
- Home ID (32 bit): The Home ID of the system in which this frame should be executed/accepted.
- Source ID (32 bit): The identifier of the transmitting device. The field is a 32-bit value that gives up to 4294967295 different Source ID's. If the transmitting device is a device, the Source ID contains the Device ID of the device, preceded by 24 '0's. Alternatively, the Source ID is an 8-bit value and each controller is given an individual ID within the system similar to the 8bit Device ID of the devices.
- Version (3 bit): Protocol/frame format version. This gives the freedom to change the frame format according to an update of the software protocol or other infrastructure enhancements.
- Dir. (1 bit): Direction of command; 0 when a command is issued, 1 when a command is acknowledged.

- Type (4 bit): The type of frame decides the contents of the rest of the frame, whether the frame contains a command or e.g. a status, and how the designation of devices is carried out. The designation depends on which and how many devices should be addressed. Some examples of possible frame types are:

Type field	Explanation
0 (0000)	Invalid use
1 (0001)	Command for a single device
2 (0010)	Command for a group of devices
3 (0011)	Command for a group of devices, masked (Device ID 1-8)
4 (0100)	Command for a group of devices, masked (Device ID 9-16)
5 (0101)	Command for a group of devices, masked (Device ID 1-16)
6 (0101)	Command for a group of devices in same single mask range (*).
7 (0111)	Command for a single device (repeat path)
8 (1000)	Command for a group of devices (repeat path)
9 (1001)	Command for a group of devices, masked (Device ID 1-8) (repeat path)
10 (1010)	Command for a group of devices, masked (Device ID 9-16) (repeat path)
11 (1011)	Command for a group of devices, masked (Device ID 1-16) (repeat path)
12 (1100)	Command for a group of devices in same single mask range (*)(repeat path).

Table 2

*) Each mask range is in step of 8 consecutive devices in step of 8. Ex. Range 0 = 1-8, Range 1: 9-16

- Length (8 bit): Amount of bytes in the frame starting from the first Home ID word until the last data byte without checksum field.
- Data byte (0-n): The data contained in the frame.
- Checksum (8bit): Checksum calculated between Home ID and the last byte of the frame. The Checksum field itself is not in calculated.

In the following, some examples of information exceeding the general frame format that can be comprised in a frame are given:

The following table shows some examples of commands for devices that can be issued in a frame:

Command function	Command	Command value
Invalid value	0	Non applicable
Toggle switch on	1	Non applicable
Toggle switch off	2	Non applicable
Start Dim	3	Dim Level to start from
Stop Dim	4	Non applicable
All Off	5	Non applicable
All On	6	Non applicable
Delete All Switches	7	Non applicable
Request Device Info	8	Non applicable
Set Light	9	Light Level
Enable repeat Path	10	Non applicable
Disable Repeat path	11	Non applicable
Set Device trigger level	12	Trigger Level
Get Device trigger level	13	Non applicable
Trigger alert	14	Trigger level
Perform calibration	15	Non applicable
Request status	16	Non applicable
Supply input related data	17	data identifier
Supply output related data	18	data identifier
Supply stored data	19	data identifier

Table 3

When issuing commands, it is off course important to specify which devices the command is addressed to. Depending on the number of devices to be addressed in one frame, different types of frames, referring to Table 2, can be utilized. The following frame type comprises the command and the individual addresses, i.e. Device ID's, of a group of recipient devices.

Home ID (Low word)			
Home ID (High word)			
Source Device ID (Low word)			
Source Device ID (High word)			
Version	D	0010 (Type 2)	Length (excl. Checksum field)
Command Value			Command
Destination Device ID 0			Number of Devices
Destination Device ID 2			Destination Device ID 1
Destination Device ID 4			Destination Device ID 3
Destination Device ID n			Destination Device ID 5
			Checksum

Table 4

- Command (8bit): The command that should be performed. See examples of commands in Table 3.
- Command Value (8bit): The actual value of the issued command. In our implementations this is an 8-bit value but could easily be expanded further.
- Destination Device ID (8bit): Array of 8bit destination device ID's indicating whether the receiving device should react to the command or not.

As can be seen in the above frame format, the addressing of devices makes up a considerable amount of the total data bits to be sent. It is an important feature of the communication protocol of the first embodiment of the present invention that it provides a way to reduce the addressing data bits. By using a Destination Device ID Mask in the frame format, the addressing data bits can be reduced dramatically. The masking of Device ID's is an operation that indicates whether certain of the receiving devices should react to the command or not. A register of entries, each entry corresponding to the enumeration of Device ID's, holds a bit pattern called a mask with each bit set to '1' where a corresponding Device ID is to be selected and '0' otherwise. By transmitting a frame with "Type" defining the mask range, see table 2, together with the "Destination Device ID Mask" (with each bit indicating whether the receiving device should react to the command or not), the addressing of each further only takes up 1 bit.

Three examples of masking of Device ID's are given in the following. The examples use mask sizes, types, indexing and layout according to the frame format of the first preferred

embodiment of the present invention. Such masking can be carried out using other layouts and formats, and the first embodiment does not restrict the idea of using masking in the designation of devices for addressing groups of devices within any communication network.

First, with an 8bit Destination Device ID Mask, up to eight devices with Device ID's from 1-8 can be addressed in a single byte reducing the amount of data dramatically. If eight devices should be addressed with the non-masked frame format (Command for a group of devices) the amount of data would be increased with 8 bytes (8 Device ID's and the "Number of Devices" field rather than the "Destination Device ID Mask").

Home ID (Low word)			
Home ID (High word)			
Source Device ID (Low word)			
Source Device ID (High word)			
Version	D	0011 (Type 3)	Length (excl. Checksum field)
Command Value			Command
Checksum			Destination Device ID Mask

Table 5

- Destination Device ID Mask (8bit): 1 bytes destination device ID mask with each bit indicating whether the receiving device should react to the command or not. The least significant bit (LSB) represents Device 1.

If we wanted to address devices in the range from 9-16 the only change in the frame format would be another value in the "Type" field of the general frame format, namely 0100 from Table 2, the LSB in the mask would now be device ID 9.

If the devices to be addressed all have Device ID's within the interval 1 to 16, the frame format should be of the "masked Device ID 1-16" type. Thereby, some or all of the first 16 device ID's can be addressed in two bytes as shown in Table 6.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Home ID (Low word)															
Home ID (High word)															
Source Device ID (Low word)															
Source Device ID (High word)															
Version			D	0101 (Type 5)				Length (excl. Checksum field)							
Command Value								Command							
Destination Device ID Mask															
								Checksum							

Table 6

- Destination Device ID Mask (16bit): 2 bytes destination device ID mask with each bit indicating whether the receiving device should react to the command or not. The least significant bit (LSB) represents Device 1.

Many systems in small households will have the most of its capacity covered by the 8 and 16 bit masks covering the first 16 devices. However, in large systems the devices to be addressed have Device ID's higher than 16, and depending of the number of devices, a more flexible masking procedure can advantageously be applied. Whereas the "Type" field typically defines the devices corresponding to the mask, the "Type" may also allow for a Mask Index range defining which 8 (or other number of) devices are covered by the following Destination Device ID Mask.

Preferably, each mask range covers 8 consecutive devices ID's in step of 8 (with the exception of type 5). In the type 6 frame format, a Mask Index (an 8bit value) indicates which mask range the following Destination Device ID Mask covers. The mask ranges are numbered consecutively, hence Mask Index '0' indicates a Destination Device ID Mask ranging from Device ID 1 to 8. Mask Index of 1 indicates a Destination Device ID Mask ranging from 9 to16. Using this method Device ID ranges up to Device ID 2040 (255 * 8) can be addressed

15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
Home ID (Low word)	
Home ID (High word)	
Source Device ID (Low word)	
Source Device ID (High word)	
Version / D / 0110 (Type 6)	Length (excl. Checksum field)
Command Value	Command
Destination Device ID Mask	Mask Index
	Checksum

Table 7

- Mask Index (8bit): The mask index indicates which Device ID ranges the Destination Device ID mask refers to.
- Destination Device ID Mask (8bit): 1 bytes destination device ID mask with each bit indicating whether the receiving device should react to the command or not. The least significant bit (LSB) represents Device ID = Mask Index * 8 + 1.

A masking procedure similar to the one described above are preferably applied to the commands issued to different devices. Thereby, several commands from a set of predetermined commands can be issued without providing the commands as such in the frame.

By providing tables of predetermined commands such as Table 3 in the protocol on both controllers and devices, the mask will be a register of entries, each entry corresponding to the enumeration of commands, forming a bit pattern with each bit set to '1' where a corresponding command is to be selected and '0' otherwise. The command values of Table 3 can be subject to a similar masking.

In order to further reduce the size of frames, data such as arrays of measured input values, images or text strings such as program strings can be subject to data compression. The protocol can apply typical software digital data compression archive formats such as Zip, TAR, gzip, CAB, ARJ, ARC, and LZH.

As a further option data can be encrypted by the transmitting device and decrypted by the receiving device preferably using software encryption means.

Data transmission using a RF carrier frequency in a typical home environment creates the possibility of transmission failure and introduction of spurious errors. The sources for introduction of errors include RF noise from other RF transceivers and electrical apparatus in general. The system of the present invention uses two-way RF components making it possible to get acknowledgment back from devices after a transmitted command has been received and executed. This procedure is outlined in the flow diagram of Figure 3. After the device has generated and sent the frame, it waits for acknowledgement from the device(s) receiving the frame. If the transmitting device has not received an acknowledgement within a specified time, it will retry the data transmission until the data has successfully been transferred or a maximum of retries has been reached.

When a frame has been received, the receiving part is prompted acknowledge the reception by the communication protocol. The destination device that received the command returns the frame with the D bit set and the receiving parts Device ID as the only Device ID in the frame. The Command Value field is used to pass the command return value (Success, Failure, etc). When the D bit is set then the Source Device ID is to be considered Destination Device ID.

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0			
Home ID (Low word)			
Home ID (High word)			
Source Device ID (Low word)			
Source Device ID (High word)			
Version	1 (D set)	Type	Length (excl. Checksum field)
Command Return Value			Command
Checksum			Destination Device ID

Table 8

The controller collects the acknowledgement replies and preferably displays a "Command successfully executed" message if all devices have received and executed the issued command. If, after a maximum number of retries, the controller have not received acknowledgement replies from one or more devices, or if it receives return commands different from "Success", it can display an error or warning message. The detail of such error message depends on the capacity of the system.

If the controller has a large capacity, such as with a PC or alike, the system may build a topology map of the system network. This Topology map preferably comprises a plan of the building or site where the system is installed, with the position of the individual devices marked on the plan. Thereby it becomes possible to specify information relating to individual devices such as which devices do not acknowledge an issued command or which input device detected what and where.

If the controller does not have a large capacity, such as with a handheld control panel, each device may still be named (e.g. "Hallway Dome lamp") in order for the user to locate a device with a malfunction.

Due to the limited range of RF signals, signal repeaters are applied in the system in order to increase the physical coverage of the system. Repeaters are known from the prior art, but the system according to the present invention includes several new features described in the following.

In the first embodiment of the present invention, all devices, whatever function they perform, are adapted to act as repeater if instructed so by a controller.

When addressing devices, it is important to take into consideration that the frame may have to be repeated by one or more times. The following frame type comprises the command and the individual addresses, i.e. Device ID's, of a group of recipient devices as well as the repeat path used to communicate with the different devices.

Home ID (Low word)			
Home ID (High word)			
Source Device ID (Low word)			
Source Device ID (High word)			
Version	D	0111 (Type 7)	Length (excl. Checksum field)
Command Value			Command
Destination Device ID 0			Number of Devices
Destination Device ID 2			Destination Device ID 1
Destination Device ID 4			Destination Device ID 3
Destination Device ID n			Destination Device ID 5
Hops			Number of Repeaters
Repeater ID n			Repeater ID 0
			Checksum

Table 9

- Number of repeater (8bit): The amount of repeater ID's in the frame.
- Hops (8bit): 1 byte field indicating how many repeaters the frame has passed through. This could be used by the repeaters as an index into the repeater ID's and to see whether they have to forward this frame or not.
- Repeater ID (8bit): 1 byte repeater ID indicating which path the frame should pass through. The Hops field can be used as an index into the repeater ID list

The repeater specific fields (Number of repeaters, Hops and repeater ID's) can be applied to all the above-mentioned frame types specified in Table 2 and will also be used in the acknowledgement of received frames.

To be able to communicate by use of repeaters an automated process is performed in order to determine which devices should be used as repeaters. It is important that the amount of repeaters in a given system is kept to a minimum in order for the response time to be as low as possible. The system is very dynamic since the controller can and will be moved around in the house and it is therefore not possible to predict the topology seen from the location of the controller. It is desirable not to do the automated repeater location process to often as it takes time and consumes power and thereby battery life.

Any controller can perform the automated repeater detection process either upon activation of the user, or if the controller finds itself in a location where it cannot reach the devices to be addressed. Figure 4 to Figure 12 illustrates an example of the steps of the automated repeater detection process according to a preferred embodiment. The system topology and the order of which some of the process step are carried out are examples and should not restrict the underlying idea of an automated repeater detection process.

Figure 4 shows a topology map for the whole system. Devices within signal range of each other are connected by lines. The ellipse shows the range of the controller.

In Figure 5 the controller asks all devices within the range of the controller, device 20, 21 22 23 and 24, of how many other devices are within their range. Device 20, 21 22 and 24 can reach three other devices and device 23 can reach four.

Figure 6 shows that the device that could reach most new devices, here device 23, is now appointed Repeater. Now, each single device within the range of the controller is asked how many devices cannot reach any new devices. Device 20, 21 and 22 in the upper left corner cannot reach any, but device 24 can reach two new.

Figure 7 shows that two devices, namely 23 and 24, have been appointed Repeaters while three devices, namely 20, 21 and 22, have been declared unsuitable as Repeaters. The newly appointed Repeater 24 can reach two new devices 25 and 26. Device 25 can reach three new devices whereas device 26 can reach one new device.

Figure 8 shows that the device 25, which could reach three new devices, has now been appointed Repeater. Two of those three devices, namely 27 and 30, can each reach three new devices and one, namely 32, can reach one new device.

Figure 9 shows that of the two devices 27 and 30, which could reach the same 3 new devices, one (27) is randomly appointed Repeater. It can be seen that the four devices, 28, 29, 30 and 31, cannot reach any new devices while the two devices 26 and 32 each can reach one new device.

Figure 10 shows that device 26 is randomly appointed Repeater. There are now two potential repeaters, one (device 32) which cannot reach any new devices and one (device 33) which can reach two new devices.

Figure 11 shows the device 33, which can reach the last two devices 34 and 35, is appointed Repeater.

The final configured system with the necessary 6 repeaters is presented in Figure 12. We have achieved that it is possible to reach any switch from any repeater.

When the controller has performed the automated repeater detection process, all devices in the system can be addressed simply by use of the process outlined in Figure 13 to Figure 18.

The topology of the system is shown in Figure 13, where R*n* indicates repeater number *n* and the triangles are devices with numbers as indicated.

Figure 14 shows that at first, the controller finds out which of the devices and Repeaters it can address directly by sending a multi-address telegram containing a list of all devices and Repeaters in the system. Time slices are allocated so that all devices have time to acknowledge the command to the controller. Which time slice each single device can apply depends on the location of the device on the list.

Figure 15 shows that the controller have received acknowledgement replies and thereby knows that it can communicate with devices 1-7 and Repeater 1 (R1). It then asks R1 to forward a multi-address telegram containing a list of the missing devices (8-10) and their command. It also sends a list of all non-used Repeaters (R2-R4). It reaches devices (8) and Repeaters (R2 R3).

Figure 16 shows that the controller now knows that it can communicate with Repeater (R2) via Repeater (R1). It then asks R2 to send a multi-address telegram containing a list of the missing devices (9-10) and their command. It also sends a list of all non-used Repeaters (R2-R4). It finds devices (9) and Repeaters (R4).

Figure 17 shows Repeater (R1) asks R3 to forward a multi-address telegram containing the missing device (10) and its command. The controller knows that there are no more non-used Repeaters in the system.

Figure 18 shows the controller knows that it can communicate with Repeater (R4) via Repeater (R1 and R2). It then asks R4 to forward a multi-address telegram containing the missing device (10) and its command. The controller knows that there are no more non-used Repeaters in the system. It finds device (10).

By use of the addressing process described above, the controller can build a table containing information about which devices can be reached by which repeater. Thereby a single device can be addressed directly through a minimum number of repeaters and it is thereby possible avoid the situation shown in figure 19 where repeater R3 is initially used to communicate with device 10.

The system according to the first embodiment can be used in a broad variety of locations to control a broad variety of functions. The system can be installed in private homes, hotels, conference centres, industrial offices, storehouses, various institutions such as kinder gardens, schools, old people's home, disabled person's home etc. The system can be adapted to control almost all types of electronic appliances, whereof some will be described specifically in a second embodiment. The system further comprises some build in functions and possibilities for obtaining or creating programs for performing further functions.

Child Protection Function

One of the functions is the Child Protection Function. This allows the user to restrict the use of one or more devices by use of a code. The restriction can have several effects, i.e.:

- the device or the appliance connected thereto are turned off and can not be turned on until a valid code has been specified. E.g. utilized to protect children towards various household equipment such as oven, toaster and hotplates.
- the device or the appliance connected thereto can only operate at a specified level, for a specified period of time, or within a specified time period unless a valid code has been specified. E.g. used to restrict the output level of the Audio equipment, restrict the amount of children's TV watching when the parents are out, or restrict the solarium working periods to those actually paid for by the customer.

- the status of the device or the appliance connected thereto can not be altered until a valid code has been specified. E.g. utilized to fix the hot water temperature at a constant temperature or fix the thermostat for the air-conditioning.

The devices controlling the restricted functions are preferably not accessible in order for other persons not to bypass the restriction. Hence, the device controlling the power outlet to the toaster are build into the wall, and the restrictions of the devices controlling the TV-sets, solariums, thermostats etc. can not removed.

Timer

Each controller preferably comprises a clock giving the date and time. This clock is used for timer functions such as for performing preprogrammed events and a time value can be read by different parts of programs comprised in the controller.

The controllers preferably comprises the following data:

Device Table

This table comprises information on all the devices, which are currently installed in the complete system. This table is also used to assign device identifiers to new devices in the system. This table may also contain information about the characteristics or fixed settings of the different devices. This table preferably also holds information related to the childproof function such as the code.

Group Table

This table comprises information on which devices from the Device Table that are grouped together in which group. This table also comprises information on the current setting of the specific group.

Mood Table

The Mood Table comprises information on which groups and devices are members of the specific Mood and it also comprises information on any specific setting the mood might consist of.

Group and Mood Name Tables

These two tables contain the user-defined alphanumerical names for the different groups and moods.

Repeater Table

This table comprises information on (the identifiers of) all devices which act as repeaters, and preferably information of which devices can be reached by each repeater.

Controller Table

This table comprises information on all controllers presently in the system, and optionally also the date and time of the last learning from another controller. This table could also contain information about the characteristics of the different controllers.

Topology Map Table

This table comprises information of all the known devices in the system and their location in system. This table also contains information of the individual devices such as alphanumerical names, characteristics and their current settings.

Trigger Action Table

This table comprises information about which actions to take when a trigger level on one or more of the input devices has been reached.

Event Table

This table is similar to the Trigger Action Table. It comprises certain events in the form of small programs, which is executed when predetermined conditions are fulfilled. Examples are turning on the coffee machine or car heater when a certain time has been read from the timer.

Program Table

This table comprises large programs, macros or routines to be executed on command.

The user interface administers setup of the system by the user, and hence allows for the user to perform functions such as learning of new devices, setup of groups and moods,

updating shared information between controllers etc, some of which will be described in the following.

The system is very flexible and additional devices can easily be added as time goes by. When a new device is added to the system it has to know which Home ID and individual Device ID to use. This procedure requires only three actions by the user, using only the device to be installed and any one controller. Everything else is taken care of by the system, and does not involve or affect any other controller or device in the system. In the first embodiment, the system learns the presence of the new device and assigns a Device ID in an automated process following the process steps:

1. The user sets the controller in device programming state, and is requested to specify which group the new device should be placed in.
2. The user presses and holds a button on the device.
3. The device sends request for Home ID and Device ID to listening controller as mentioned in 1.
4. Device awaits frame with Home ID and Device ID from controller.
5. Controller looks up next available Device ID and sends Home ID and allocated Device ID to device.
6. Device stores the received Home ID and Device ID in non-volatile memory.
7. The group table in non-volatile memory on the controller is updated with the new Device ID.

This way each device will be placed in a group on the controller. In the alternative where the device is programmed with a unique Device ID from factory, the process will be somewhat simpler:

1. The user sets the controller in device programming state, and is requested to specify which group the new device should be placed in.
2. The user presses and holds a button on the device whereby the device sends its Device ID to listening controller as mentioned in 1.
3. Device awaits frame with Home ID from controller.
4. Controller sends Home ID to device.
5. Device stores the received Home ID in non-volatile memory.

6. The group table in non-volatile memory on the controller is updated with the new Device ID.

The simplicity of this procedure is due to the unique addresses of all devices in the system. Since all devices can be addressed individually and due to the functionality of the protocol, each device can be set up and included/excluded individually.

If the device is already within the system but have to be added to a new or existing group, the procedure preferably comprises the following steps:

1. The user sets the controller in group programming state and the user is requested to specify which group the new device should be placed in.
2. The user presses and holds a button on the device.
3. The device sends its Device ID to listening controller.
4. Controller stores the received Device ID in the selected group table.

Although this seems as a rather different procedure than the procedure for adding new devices, the actions performed by the user during the procedures are the same, since the system administers the providing and storing of the relevant information.

If the controller has large capacity and is capable of building and administering topology maps, the procedure may be carried out differently, e.g. by simply installing the device physically and thereafter positioning a new device on the corresponding position in the topology map on the controller. The system may now itself find which (existing or new) repeaters should be used to communicate with the new device and may itself prepare the device for receiving Home and Device ID.

The learning processes outlined above may be organized differently, however it is important for the overall functionality of the system that the device and the controller themselves (assign and) learn each other's ID's. The device will be added to at least one (existing or new) group after the first installation. Devices can belong to several groups, and a single device is inserted in a group by adding its Device ID to the relevant group table in the controller memory, hence without influence for any other devices at any time.

Since a device shall respond to all controllers in a household, all controllers are programmed with the Home ID (i.e. preferably the device identifier number of the first controller utilized to program a device). Also, some functions, groups, moods or other tables in the system may be "universal" in the sense that it is preferable to have the same tables on all controllers in the system, even though they are originally learned on one specific controller. This is possible in the system of the present invention, since controllers, whether new or already in use, can learn from another in order to share information such as in copying of information from one controller to another or updating changes performed in the shared information of one controller. This will be referred to as "learning" in the following.

This is done by putting the first controller in "Teach Mode" and the new controllers in "Listen mode" and starting the transfer on the transmitting first controller. It is possible to transfer all data of a controller to other controllers. Optionally, the user can select the information to be transferred in order to preserve the individuality of controllers. Thereby a full copy of the information comprised in the transferring controller can be provided to a new controller, whereas only the specific functions or programs, the repeater tables and topology maps and synchronization signals are transferred to an existing controller in order to update it to the latest changes in the system.

In a second preferred embodiment, the system comprises a set of products for controlling the power level to electric appliances such as Lighting in homes. This second embodiment will be referred to as Power & Lighting control.

Apart from being a Power & Lighting control system, the second preferred embodiment is to form a base for a complete home control system including other subsystems such as HVAC control, alarm system control, access control, etc. Thus, the preferred embodiment incorporates a conceptual, scaleable system (incorporated in the communications protocol) allowing for infrastructure enhancements as new products are introduced.

This section mainly deals with those aspects related to the Power & Lighting control system not comprised in the high-level description of general parts of the conceptual, scaleable system given in the previous description of the first embodiment of the

automation system. However, features only described in detail in relation to the second embodiment can also be used in the first general embodiment.

The Power & Lighting control system consists of the following elements

- Controllers

  In the Power & Lighting embodiment, the controller is preferably a mobile control panel such as a remote control, so that the use or programming of the system is not restricted to certain locations. The initial implementation and often also later setting of a device is carried out in the vicinity of the device. Although the data protocols makes use of addressing of devices using device identifier's, the person performing the programming can rely on his/her visual confirmation of the connection of an appliance to a given device. Hence the programming interface does not rely on the users ability to remember device codes, assigned numbers or alike.

- Output devices

  The output devices are operationally connected between a power source and an electric appliance, typically in the form of an outlet socket connected to the power supply socket. The output devices can perform switching, dimming and optionally metering of power or current delivered to the electric appliance. Also, the output devices are able to perform as repeaters in the system.

Among other things, the following actions can be performed with the controller:

- Assigning unique identifiers to new devices.
- Programming devices to belong to the system (i.e. programming them with the unique Home ID number)
- Programming devices to belong to one or several groups
- Executing the on/off function on a given group
- Executing the dim function on a given group
- Programming devices to belong to one or several moods
- Executing a given mood
- Naming a given group with alphanumerical characters
- Naming a given mood with alphanumerical characters
- Setting a child protection on a device
- programming the timer

- initiating and interrupting the keylock function
- etc.

Several controllers can be utilized within a system. In that case, two types of communication is needed between the controllers:

- Ensuring adherence to the Home ID Number.
- Teaching/learning of various data on controllers.

In many cases, it can be convenient to have an identical set-up of the various control panels in order to ease the operation. This can be ensured by transferring data from a given controller to any of the other controllers.

The mobile controller is powered by batteries and is designed to be carried around, this design include e.g. a keyboard lock. The controller preferably includes a display such as an LCD (Liquid Crystal Display) display. The controllers can optionally interface with a computer; moreover, a computer may also act as a controller in the system.

A number of different types of output devices are feasible, ranging from low voltage switches to HVAC output devices etc.

Each output device is equipped with a unique device identifier number within the Home ID group. A given output device is hooked up to the system by programming it with the Home ID number. The output device can only belong to one system at a time, i.e. it can only react to commands characterized by one unique Home Id number.

Each output device preferably has only one actuator button. This button is used every time the device should notify a controller of its Device ID during programming procedures. The button is preferably also used to turn on/off and dim the output power supplied by the device without the use of a controller. However, this function can be overruled by the child protection function by making the button inactive for power adjustment purposes. Preferably, the different functions of the button are utilized by pressing the button for different periods of time, e.g. a short period for turning on/off and dimming up/down when the button is pressed continuously.

Among other things, the output devices can perform the following actions:

- Inform a controller of its presence and get ready to receive the Home ID and Device ID.
- Toggle the current on/off by use of a button on the device
- Dim the current by use of a button on the device
- Execute commands received from a controller
  - Dim the current
  - Repeat the command received to other output devices
  - Toggle the current On/Off
  - Acknowledgement of received and executed commands
  - Reply with device status
- Meter the power or current supplied to the electric appliance connected to the output device, and save, process and transmit the metered information.

The various output devices in the power & lighting system are treated differently by the controllers depending on the Logical Output Class they belong to.

In order to control a single device, it may be mandatory to create a group consisting of just one device such as a particular switch.

Group ID's within a given system are preferably numbered 1 to 64. Each group can be assigned to either a speed button on the controller (1 to 8 in the present embodiment) or via assigned a number from 9 to 64 via the menu system. When programming a device to the system (i.e. when informing the device about the Home Id number and device identifier it must react to), the device is immediately assigned to belong to a group.

A device can be programmed to belong to all 64 groups. A given group is defined in the memory of the controller. As such, a particular device can belong to up to 64 groups in each controller.

Moods are groups of devices in which the setting of each device is set to a desired dim level or current.
Mood ID's are preferably numbered 1 to 32.

The method for programming a mood consist of two steps:

1) Specify the output devices which should be used to create a mood
2) Specify any specific setting of each group in the mood, which were just created.

The following paragraphs describe some of the functionality comprised in the Lighting system.

Group or mood switching

By pressing "Group Button" the user enters functions dealing with a single or a group of appliances such as lamps. By pressing "Mood Button" the user enters functions dealing with moods (e.g. setting a predefined Lighting for the room)

Group on/off setting

A user can turn on or off a single or a group of appliances by either using the speed buttons 1-8 or by using the scroll button. If the user uses button 1-8 then only a short press is required. The button will work as a toggle. If the scroll button is used the user must scroll to the desired group and press an OK button.

Group Dim setting

A user can dim the current to a single or a group of appliances such as lamps (the same group as the on/off function) by either using the speed buttons 1-8 or by using the scroll button. If buttons 1-8 is used, the dimming will be activated when the button is pressed continuously. When the correct dimming level is reached the button is released. If the scroll button is used the user must scroll to the desired group and press additional buttons to dim up/down.

Command acknowledgement on display

Each command initiated by the user will be acknowledged through the display. A typical acknowledgement could for example be that "all lights are now off."
Upon activating a device, the control panel expects an acknowledgement receipt from the device that the command has been carried out. Two events can occur:

The device does not respond with an acknowledgement:

- The controller indicates e.g. *"out of reach or device defect"*

The device responds with an error message such as No Current Detected In Mains:

- The controller indicates e.g. *"Bulb or lamp defect"*

The device responds with Command Executed:

- The controller indicates e.g. *"All OK"*

Mood programming function

Moods can be programmed into the control panel by pre-setting the different devices to the desired current level, and afterwards storing this level in the control panel. Moods can be stored in buttons 1-8 or by using the scroll button for additional storage.

Mood setting function

A user can activate pre-set moods (e.g. TV watching or working mood) by using the control panel's 1-8 buttons. If the scroll button is used the user must scroll to the desired group and press an OK button.

All on/off setting

A user can turn on or off all switches by pressing the "all on/off" button. A device will per default be programmed to respond to the "all on/off" button, but can also be programmed not to.

All on/off programming

Should a user require that a certain device should not respond to "all on/off" it can be done so by setting this on the control panel. This could e.g. be beneficial for the fish tank or the outdoor lights.

Random on/off setting

The user can use the control panel to set a device to random turn on and off (i.e. used to keep away burglars). The device will keep turning on and off with e.g. 3 hrs. interval and abort this action next time it receives any instruction from the control panel. The time interval in which the control panel should randomly switch on and off can also be set (e.g. from 18:00 to 23:00)

Random on/off programming

Should a user require that a certain device should not respond to "random on/off" it can be done so by setting this on the control panel. This could e.g. be beneficial for the fish tank or the outdoor lights.

Device Resetting

All devices can be reset whereby the Home ID and the Device ID held by the device is deleted and all references to the Device ID in the controller is deleted. In the Power & Lighting embodiment, the resetting is carried out by setting the controller in "device reset" mode and pressing the actuator button on the device. This makes the device transmit information to the controller, which then perform the resetting.

In the Power & Lighting embodiment, the controller is a control panel with a LCD display on which a very user-friendly user interface is presented.

The controller, which is roughly outlined in Figure 19 and has the following buttons:

- The all On/Off button which will either switch all output devices On or Off except for those device that have been configured not to be included. The set-up of this function is specified later.
- The eight speed buttons for quick access to the most commonly used groups or moods.
- The Group button which sets the state of the speed buttons to be groups
- The Mood button which sets the state of the speed buttons to be moods
- The OK button which is mainly used within the menu system.
- The Left and Right buttons which among other things are used to maneuver in the menu system.

The controller handles functions that the user wishes to perform within the system. In the following, the procedures for performing some of the necessary functions within the systems are outlined.

There following three things can be done to the groups after they have been created such as during addition of new devices.

- Name the group: Each group can be named with alphanumerical numbers to improve the user friendliness.

- Remove a switch from a group: When the different devices have been added to a specific group then this menu functionality enables the user to remove individual switches from a specific group. The procedure of how this is done is shown in Figure 20. First the user selects the "Remove Switch from Group" menu option and is prompted for the group number in which the device is to be removed. Then the user has to press a button on the output device in order for controller to get the device id to remove. When the button on the output device has been pressed to specific device has been removed from the group table and the menu system return to the main menu.

- Delete a group: This menu item allows the user to completely delete a group.

The following options are available in the mood menu section.

- Create a Mood: This menu item allows the user to add devices into a mood. The procedure is outlined in Figure 21. First the user selects the "create a Mood" menu option and is prompted to select devices to include in the mood. The user then presses a button on all of the output devices which are to be included in the mood and presses OK when done. The output devices then transmit its current dim level to the controller. Then the user is prompted for a mood number to add the already selected devices into. If the mood is already is in use then user has to determine whether to replace the mood with the selected devices or to choose another mood number. The user then has the option to name the mood. The user can now select the alphanumerical characters on a toggle menu using the Left/Right and the OK button. When the name is typed, the user holds the OK button for more than 2 seconds whereby the controller saves the mood name and returns to the main menu.

- Name a Mood: Each mood can be named with alphanumerical numbers to improve the user friendliness.

- Removed switches from Mood: When the different devices have been added to a specific mood then this menu functionality enables the user to remove individual

switches from a specific mood again. The method is equivalent to the method used when removing switches from groups.

- Delete a Mood: The menu item allows the user to completely delete a mood.

The all On/Off functionality is per default set to be all devices known by the controller. Individual switches can repeatable be removed or added from this function. There is also a possibility to customize whether the button is to toggle On/Off or only to use this button as a switch off button.

To ease the use of having several controllers operating within the same Home ID the product has the feature to update each other with the different tables and settings. The updating process is shown in Figure 22. The user is first prompted for whether this controller is to be receiving updates or sending updates. If the user selects receiving updates the controller enters receive configuration mode and will return to the main menu when the updates has been received. If the user selects the option to update another controller then the user is prompted whether to update the system and thereby the Home ID alone or Home ID and all tables containing Groups, Moods, etc. When the update is completed the system return to the main menu.

As mentioned, some or all the output devices can include means for measuring the power supplied to the one or more appliances connected to each device. The power measuring means are preferably means for measuring the current supplied to the appliance at constant voltage, in order to allow for determination of the power, in e.g. KW/h or VoltAmpere/h, received by the one or more appliances connected to the device. A possible way to implement power meter functionality in the existing switches is outlined in Figure 23. This implementation requires the consuming appliance to pull it's current in a sinus form which would be the case for ordinary lamps. The power meter would then be able to measure volt-amperes, which would be identical to Watts.

This power meter function allows the controller to monitor the power consumption of individual appliances, all appliances in a given group, all appliances in a given mood, and of all appliances connected to the system. Hence, one can practice a total power metering, revealing detailed information of specific appliances or sections in the building. Preferably, the devices are adapted to sum up the power consumption for a given period

of time and to report the power consumption to a controller either in response to a request to do so from the controller, or on its own motion at e.g. a predetermined time or total power consumption.

Optionally, an output, or a controller, can also keep track of the total amount of time the output device have been "on" and preferably also the number of times the output device have been dimmed or switched on/off. These functions can be used to perform statistical parameters for the use of the system.

It is possible to combine a number of devices in a joint unit 50 as shown in Figure 24, in order to allow for a number of controllable outlets to be supplied from a single power outlet. The joint unit 50 is preferably combined with an extension cord 52. Alternatively, the joint unit can be plugged directly into the wall.

The joint unit 50 has multiple outlet sockets 51 with entries 53 adapted to the plugs of the region where the system is used. Each outlet features the same functionality as a single device and there is an actuator button for each outlet. Preferably there is a dedicated processor and memory to each outlet and all outlets share a common transceiver. It is of course also possible to have a common processor and memory, or for each outlet to have a transceiver.

The controllers and the devices according to the first and/or second embodiment have some common hardware such as:

- RF Transceiver with the following characteristics:
  - Very flexible frequency band
  - Programmable output power
  - Data-rate up to 9600 bit/s
  - FSK modulation
  - Suitable for frequency hopping protocols
  - Low power consumption

- Microprocessor with the following characteristics:
  - High Speed RISC Architecture
  - Very Low power consumption
  - Integrated RAM, EEPROM and FLASH memory

In the second embodiment, the Power & Lighting system, the control panel and the output devices preferably further comprises:

The control panel:

- Two line LCD display
- 13 button soft keypad
- Battery holder for three type AAA batteries
- Timer chip which is used to show the time and set timers for the burglar deterrent function.

The output devices:

- The components on the devices are powered from the 220/110-volt power outlets in the wall after it has been transformed down to 3.3v. The dim and on/off function is controlled by a very powerful TRIAC. The output devices have one actuator button used in programming procedures and to adjust the power supplied by the device.

CLAIMS

1. An automation system for controlling and monitoring devices comprising:

a first controller comprising:

a transmitter for transmitting signals,

a receiver for receiving signals,

a first memory holding a unique first identifier,

a second memory adapted to hold a device identifier, and

a first processor adapted to store one or more device identifiers in the second memory,

a first device to be controlled by the first controller, said first device comprising:

a transmitter for transmitting signals,

a receiver for receiving signals,

a first memory adapted to hold the device identifier identifying the first device,

a second memory adapted to hold the unique first identifier, and

a first processor adapted to (receive and) store the unique first identifier in the second memory,

wherein the first device is adapted to respond only to signals comprising the first unique identifier.

2. An automation system according to claim 1, wherein transmitters of the first controller and the first device are radio frequency transmitters, and wherein receivers of the first controller and the first device are radio frequency receivers.

3. An automation system according to claim 1, wherein the first processor is further adapted to generate signals containing the unique first identifier and at least one device identifier.

4. An automation system according to claim 1, wherein the unique first identifier in the controller is set during fabrication of the first controller.

5. An automation system according to claim 1, wherein all identifiers are in the form of binary identification strings.

6. An automation system according to claim 1, wherein the device identifiers identifying the devices are unique.

7. An automation system according to claim 6, wherein the device identifier identifying the first device comprises a first and a second part, said first part being the unique first identifier and said second part being specific for the first device within the group of devices only responding to signals comprising the first unique identifier.

8. An automation system according to claim 7, wherein the processor of the first controller is adapted to generate the second part of device identifier when the device is implemented in the system.

9. An automation system according to claim 1, wherein the first and the second memory are the same memory.

10. An automation system according to claim 1, wherein the first device is adapted to generate and transmit a signal comprising data to the first controller, and wherein the first controller is adapted to generate and transmit a signal comprising data to the first device.

11. An automation system according to claim 10, further comprising means for compressing data to be comprised in a signal.

12. An automation system according to claim 10, further comprising encryption means for encrypting data to be comprised in a signal.

13. An automation system according to claim 1, wherein the second memory of the first controller comprises a first data table adapted to hold the device identifiers of one or more devices to be controlled by the first controller.

14. An automation system according to claim 13, wherein the second memory of the first controller further comprises a first alphanumerical string being held in relation to the first data table.

15. An automation system according to claim 13, wherein the first data table further comprises one or more predetermined settings being held in relation to one or more of the device identifiers held in the first data table and characterizing the operational state of the corresponding devices.

16. An automation system according to claim 15, wherein the first processor of the first controller is further adapted to generate signals comprising at least one device identifier and at least one predetermined setting held in relation to said device identifier.

17. An automation system according to claim 1, wherein the first processor of said first controller is further adapted to generate a signal comprising commands for devices, said signal being addressed to one or more devices controlled by the first controller.

18. An automation system according to claim 17, wherein the first device further comprises a status setting for determining whether the device should respond to the command of the signal addressed to one or more devices.

19. An automation system according to claim 1, further comprising a second controller comprising:

a radio frequency transmitter for transmitting signals,

a radio frequency receiver for receiving signals,

a first memory holding a unique first identifier,

a second memory adapted to hold a device identifier, and

a third memory adapted to hold the unique first identifier of the first controller,

a first processor adapted to store one or more device identifiers in the second memory.

20. An automation system according to claim 19, wherein

the first processor of the first controller is further adapted to generate a signal comprising the first unique identifier, and

the first processor of the second controller is further adapted to receive said signal from the receiver and store said first unique identifier in the third memory of the second controller.

21. An automation system according to claim 20, wherein the second controller is adapted to respond only to signals comprising the first unique identifier.

22. An automation system according to claim 19, wherein

the first processor of the first controller is further adapted to generate a signal comprising a first device identifier of a device controlled by the first controller, and

the first processor of the second controller is further adapted to receive said signal from the receiver and store said first device identifier in the second memory of the second controller.

23. An automation system according to claim 22, wherein the second memory of the first controller comprises a first data table adapted to hold the device identifiers of one or more devices to be controlled by the first controller, and wherein the signal generated by the first controller further comprises the first data table of the first controller.

24. An automation system according to claim 22, wherein the second memory of the first controller comprises a first data table adapted to hold the device identifiers of one or more devices to be controlled by the first controller and a first alphanumerical string being held in relation to the first data table, and wherein the signal generated by the first controller further comprises the first alphanumerical string.

25. An automation system according to claim 22, wherein the second memory of the first controller comprises a first data table adapted to hold the device identifiers of one or more devices to be controlled by the first controller and one or more predetermined settings being held in relation to one or more of the device identifiers held in the first data table and characterizing the operational state of the corresponding devices, and wherein the signal generated by the first controller further comprises the at least one predetermined setting.

26. An automation system according to claim 1, wherein the first devise is adapted to generate an output.

27. An automation system according to claim 26, wherein the output is a signal to an appliance operationally connected to the first device, and wherein said signal comprises one or more instructions related to the operational state of the appliance.

28. An automation system according to claim 26, wherein the output generated by the first device is adjusted in response to a received signal.

29. An automation system according to claim 28, wherein the first processor of the first device is adapted to generate and transmit a signal in response to a received signal.

30. An automation system according to claim 28, wherein the first processor of the first device is adapted to generate and transmit a signal in response to a signal from the first processor of the first device.

31. An automation system according to claim 28, wherein the output is electric power.

32. An automation system according to claim 28, wherein the first device can adjust the output power at a level according to a setting comprised in a received signal.

33. An automation system according to claim 26, wherein the first device is adapted to restrict the output in response to a received first set of instructions, and wherein said restriction can only be removed in response to a received second set of instructions.

34. An automation system according to claim 33, wherein the first controller is adapted to generate the first and the second set of instructions, and wherein the user is must provide a predetermined code in order for the first controller to generate said second set of instructions.

35. An automation system according to claim 1, wherein the first device is adapted to receive input.

36. An automation system according to claim 35, further comprising a first sensor operationally connected to the first processor of the first device, and wherein the first sensor upon receiving a signal, forms a signal received by the first processor as input.

37. An automation system according to claim 35, wherein the received input is stored in the second memory of the first device.

38. An automation system according to claim 35, wherein the received input is transmitted by the first device.

39. An automation system according to claim 35, wherein the received input is stored in the second memory of the first device and at a later time transmitted by the first device.

40. An automation system according to claim 35, wherein a signal is transmitted by the first device in response to the received input.

41. An automation system according to claim 36, wherein the first sensor is a sensor selected from the group consisting of electromagnetic radiation sensor, luminosity sensor, moisture sensor, movement sensor, temperature sensor, mechanical actuator contact, sound sensor, pressure sensor, electric signal sensor, smoke detector, audio pattern

recognizing means, visual pattern recognizing means and molecular composition analyzing means.

42. An automation system according to claim 36, wherein the sensor measures the impedance of an electric signal, such as the capacitance, such as the resistance, such as the inductance.

43. An automation system according to claim 1, wherein at least one device is adapted to act as repeater by receiving a signal carrying information, and transmitting a signal carrying at least some information also carried by the received signal.

44. An automation system according to claim 43, wherein all devices are adapted to act as repeaters.

45. An automation system according to claim 43, wherein the system is adapted to designate devices to be repeaters so as for the first controller to be able to transmit signals to all devices controlled by the first controller.

46. An automation system according to claim 45, wherein the first processor of the first controller is adapted to

1) transmit a first type of signal which request a response in the form of a second type signal from all devices receiving the first type signal, wherein said first type signal comprises instructions for the devices to transmit a third type signal which request a response in the form of a fourth type signal comprising the identifier of the device responding with the fourth type signal, and wherein said second type signal comprises the identifier of the device responding with the second type signal and the identifiers of the devices responding with the fourth type signals,

2) determine the devices transmitting the second signal comprising identifiers from devices responding with the fourth type signals and select and designate one device to be a repeater,

3) determine which of the second signals, if any, comprises identifiers not comprised in the second type signal from the repeater designated in 2) and designating the devices transmitting said second type signals, if any, to be repeaters.

47. An automation system according to claim 46, wherein the first processor of the first controller is further adapted to

4) transmit a fifth type signal to all repeaters instructing each repeater to transmit a first type signal to devices which did not previously respond with a second type signal and to transmit the received second type signal to the first controller, optionally by use of other repeaters,

5) repeat step 2) and 3)

48. An automation system according to claim 47, wherein the first processor of the first controller is further adapted to repeat step 4) and 5) until all devices controlled by the first controller have responded with a signal of the second or the fourth type.

49. An automation system according to claim 48, further comprising a second data table in the first controller, said second data table comprising the identifiers of the devices designated as repeaters in step 3, and the identifiers of the devices from which each repeater received a signal of the fourth type, stored in relation to the identifier of said repeater.

50. An automation system according to claim 48, further comprising a second data table in the first controller, said second data table comprising the identifiers of all devices controlled by the first controller, and the identifier of the repeater which received a signal of the fourth type from each device, stored in relation to the identifier of the device.

51. A protocol for generating a first type of frame for use in an automation system according to claim 13, said first type of frame comprising one or more commands, said protocol comprising a procedure of masking a first group of device identifiers in the first table of the first controller in order to generate a string of bits forming part of the frame, so that each bit corresponds to a device identifier and a device of the first group, the value of

said bit determining whether the one or more commands applies to the corresponding device.

52. A protocol for generating a second type of frame for use in an automation system according to claim 1, wherein the first controller is adapted to generate and transmit a frame of the second type comprising two or more instructions from a second table of instructions comprised in the second memory of the first controller, said protocol comprising a procedure of masking a first group of instructions in the second table of the first controller in order to generate a string of bits forming part of the frame, so that each bit corresponds to an instruction of the first group, the value of said bit determining whether the one or more corresponding commands applies to devices receiving said frame.

53. A device in a two ways communication automation system, said device being coupled to a first electrical appliance for providing power to the first electrical appliance and comprising

a transmitter for transmitting signals,

a receiver for and receiving signals,

means for adjusting the power supplied to the first electrical appliance in response to a received signal,

first means for measuring the power supplied to the first electrical appliance, said measuring means giving an output signal, and

a first processor operationally connected to the output of the first measuring means, said first processor being adapted to generate a signal comprising information relating to the output signal of the measuring means.

54. A device according to claim 53, where the transmitter and the receiver is a radio frequency transmitter and a radio frequency receiver for transmitting and receiving radio frequency signals.

55. A device according to claim 53, further comprising an analogue to digital converter operationally connected between the output of the first measuring means and the first processor.

56. A device according to claim 53, further comprising a first memory, and wherein the first processor is adapted to store information relating to the output of the measuring means on said first memory.

57. A device according to claim 53, wherein the processor is adapted to store the output from the first measuring means in the first memory over a time period so as to monitor the power consumption of the first electrical appliance.

58. A device according to claim 57, wherein the processor is adapted to generate a signal for transmission by the transmitter, said signal carrying information from the first memory.

59. A device according to claim 53, wherein the processor is adapted to perform mathematical operations on the output from the first measuring means.

60. A device according to claim 53, wherein the power measuring means measures the power supplied to the first electrical appliance by measuring the current supplied to the first electrical appliance.

61. A device for use in an automation system, said device being coupled to a first electrical appliance for providing power to the first electrical appliance and comprising

a first receiver for receiving signals,

a first transmitter for transmitting signals,

a memory adapted to store at least a first and a second identifier,

a first power inlet,

two or more power outputs from the device, and

processor means for handling received signals and operationally connected to means for adjusting the power supplied by the two or more power outputs,

wherein the first and second identifier relates to a first and second outlet in that the power supplied by the first power output is adjusted in response to a received signal comprising the first identifier, and the power supplied by the second power output is adjusted in response to a received signal comprising the second identifier.

62. A device according to claim 61, wherein the first transmitter and the first receiver can transmit and receive radio frequency signals.

63. A device according to claim 61, wherein the memory comprises memories according to the number of outputs, each memory holding an identifier related to a power output.

64. A device according to claim 61, comprising processors according to the number of outputs, each processor being adapted to handle signals comprising an identifier related to a power output.

65. An automation system according to claim 61, wherein the first device can adjust the output power at a level according to a setting comprised in a received signal.

66. A method for operating an automation system for controlling and monitoring devices comprising the steps of

providing a first controller comprising:

a radio frequency transmitter for transmitting signals,

a radio frequency receiver for receiving signals,

a first memory holding a unique first identifier,

a second memory adapted to hold one or more device identifiers, said second memory further comprising one or more data tables adapted to hold device identifiers for devices controlled by the first controller

a first processor adapted to store a device identifier in the second memory,

providing one or more devices to be controlled by the first controller, said one or more devices each comprising:

a radio frequency transmitter for transmitting signals,

a radio frequency receiver for receiving signals,

a first memory adapted to hold the device identifier identifying the device,

a second memory adapted to hold a unique first identifier, and

a first processor adapted to receive and store the unique first identifier in the second memory,

wherein each device is adapted to respond only to signals comprising the first unique identifier.

transmitting a first signal from the first controller, the first signal comprising the unique first identifier and the identifier of a first device.

67. A method for operating an automation system according to claim 66, further comprising the step of receiving the first signal at the first device, and storing the identifier of the first device in the first memory and the unique first identifier of the first controller in the second memory.

68. A method for operating an automation system according to claim 67, wherein the first device is first activated by activating an actuator operationally connected to the first processor of the first device.

69. A method for operating an automation system according to claim 66, further comprising the step of storing the transmitted identifier of the first device in one or more of the one or more data tables in the second memory of the first controller.

70. A method for operating an automation system according to claim 66, further comprising the steps of storing a group of identifiers, said group comprising the identifiers for two or more devices, in the second memory of the first controller and storing in relation thereto a group identifier for designating said device identifiers.

71. A method for operating an automation system according to claim 70, further comprising the steps of:

selecting a command on the controller,

selecting a group on the controller, and

generating, in response to these selections, a signal comprising the command, the first unique identifier and the group of device identifiers designated by the group identifier of the selected group.

72. A method for operating an automation system according to claim 70, wherein the operation of each device can be characterized by two or more different settings, said method further comprising the steps of storing a one or more device identifiers and/or one or more group identifiers in the second memory of the first controller and storing in relation to each of said identifiers a setting characterizing the operation of the device or group of devices, and storing in relation to said identifiers and said settings a mood identifier for designating said identifiers and said settings.

73. A method for operating an automation system according to claim 72, further comprising the steps of:

selecting a mood on the controller, and

generating, in response to the selected mood, a signal comprising the first unique identifier, the device identifiers and the related settings designated by the mood identifier of the selected mood, and the device identifiers designated by the group identifiers and the related settings designated by the mood identifier of the selected mood.

74. A method for changing the status of one or more devices in an automation system comprising the steps of

providing a first controller comprising:

a radio frequency transmitter for transmitting signals,

a second memory comprising one or more data tables adapted to hold device identifiers for devices controlled by the first controller,

a first processor adapted to generate a signal comprising the device identifiers in data tables of the second memory,

providing one or more devices to be controlled by the first controller, each device comprising:

a radio frequency receiver for receiving signals,

a first memory adapted to hold a device identifier identifying the device,

a first processor adapted to receive process signals,

wherein the one or more devices have two or more states characterizing the operation of the devices, and wherein the first processor of said one or more devices comprises a setting which determines whether the device should change its state in response to a signal sent from the first controller, said signal comprising a command for changing the state of the device,

generating in the first controller a first signal addressing one or more devices, said first signal comprising one or more commands for changing the state of the devices,

transmitting said first signal,

receiving said first signal at each of the devices, and

if the setting determines that a device should change its state in response to the first signal, then changing the state of the device according to the first signal, and

if the setting determines that a device should not change its state in response to the first signal, then no change in the state of the device.

75. A method for changing the status of one or more devices according to claim 74, further comprising the steps of providing

a first memory holding a unique first identifier, and

a radio frequency receiver for receiving signals

to the first controller, and providing

a radio frequency transmitter for transmitting signals, and

a second memory adapted to hold the unique first identifier

to each of the one or more devices.

76. A method for changing the status of one or more devices according to claim 74, wherein said first signal is addressing all devices controlled by the first controller.

77. A method for changing the status of one or more devices according to claim 74, wherein the first signal is addressing a randomly chosen selection of the devices controlled by the first controller.

ABSTRACT

The present invention discloses an automation system for controlling a network of devices, the system provides an improved functionality based upon two-way RF communication, an advanced communication protocol and unique addressing of controllers and devices in the system. Hence both controllers and devices comprise transmitter, a receiver, a processor and a memory. The devices may control the operation of an electrical appliance connected thereto, also the devices may themselves provide a function in the form of an output. The devices of the system may also receive input, e.g. from a sensor connected thereto. The devices of the system are adapted to repeat signals in order to expand the signal range of the system. The controllers of the system can control devices individually or collectively and execute programmed events relating to the operation of one or more devices.

459-425P

Attorney Docket No.

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COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT AND DESIGN APPLICATIONS

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Insert Title: RF HOME AUTOMATION SYSTEM

Fill in Appropriate Information - For Use Without Specification Attached:

the specification of which is attached hereto. If not attached hereto,
the specification was filed on _____ as
United States Application Number not yet known ;
and amended on _____ (if applicable)l and/or
the specification was filed on _____ as PCT
International Application Number _____; and was
amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

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Insert Priority Information: (if appropriate)

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Month/Day/Year Filed)	☐ Yes	☐ No
(Number)	(Country)	(Month/Day/Year Filed)	☐ Yes	☐ No
(Number)	(Country)	(Month/Day/Year Filed)	☐ Yes	☐ No
(Number)	(Country)	(Month/Day/Year Filed)	☐ Yes	☐ No

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Country	Application Number	Date of Filing (Month/Day/Year)

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Insert Prior U.S. Application(s): (if any)

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

459-425P
Attorney Docket No.

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

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Name of Inventor →
Date This Document is Signed

Insert Residence
Insert Citizenship →

Insert Post Office Address →

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Residence (City, State & Country)		CITIZENSHIP
POST OFFICE ADDRESS (Complete Street Address including City, State & Country)		

*DATE OF SIGNATURE

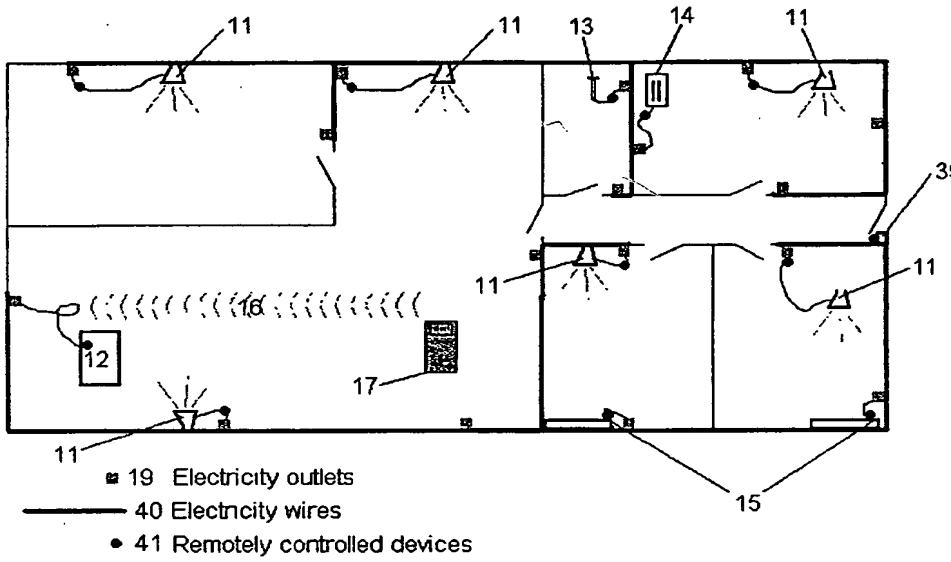

Figure 1

42	System	transmitter	receiver
43	System	controller	device

Figure 2

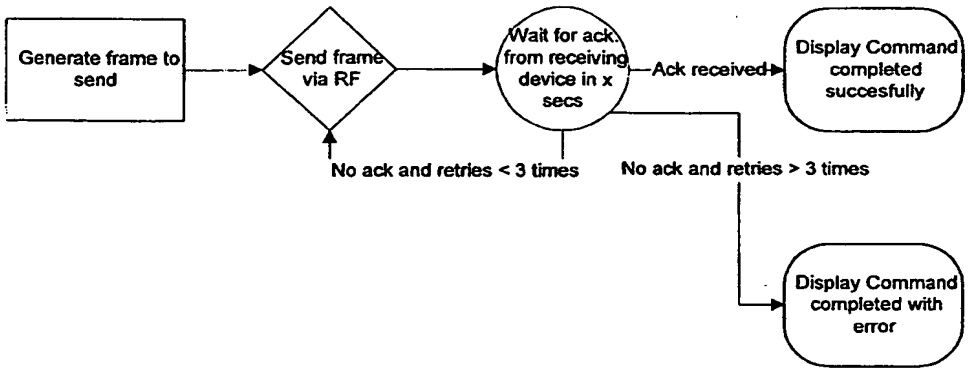

Figure 3

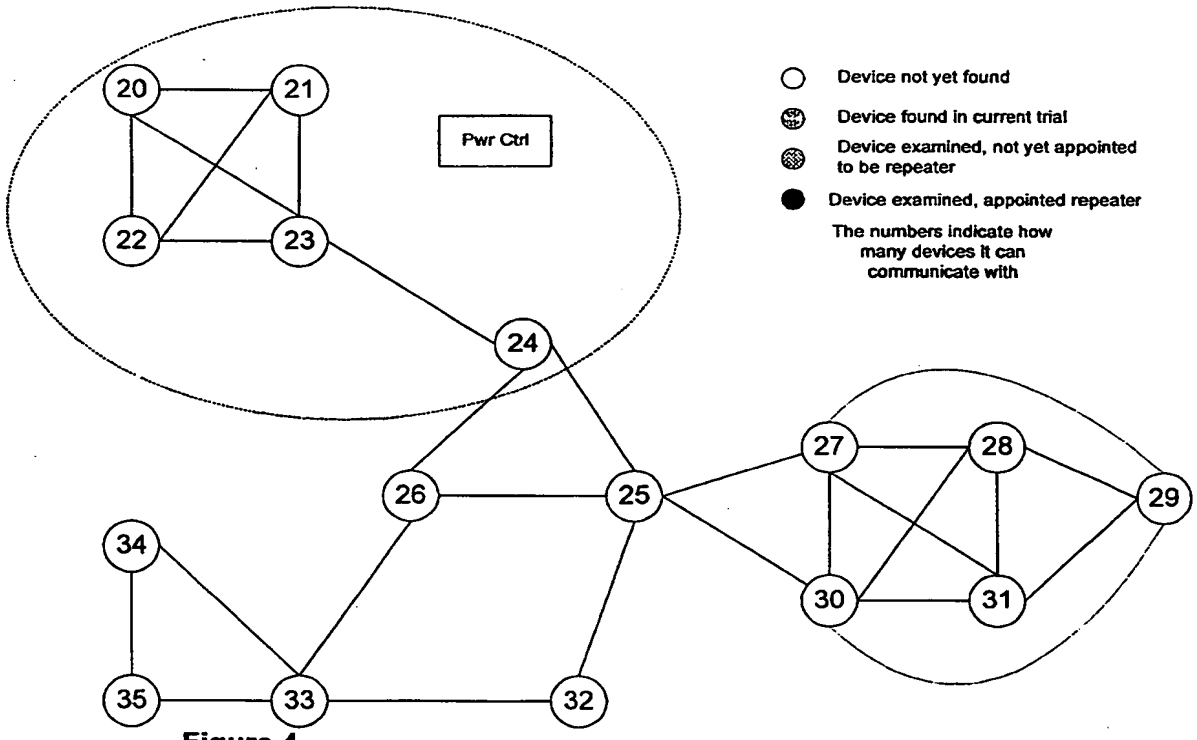

Figure 4

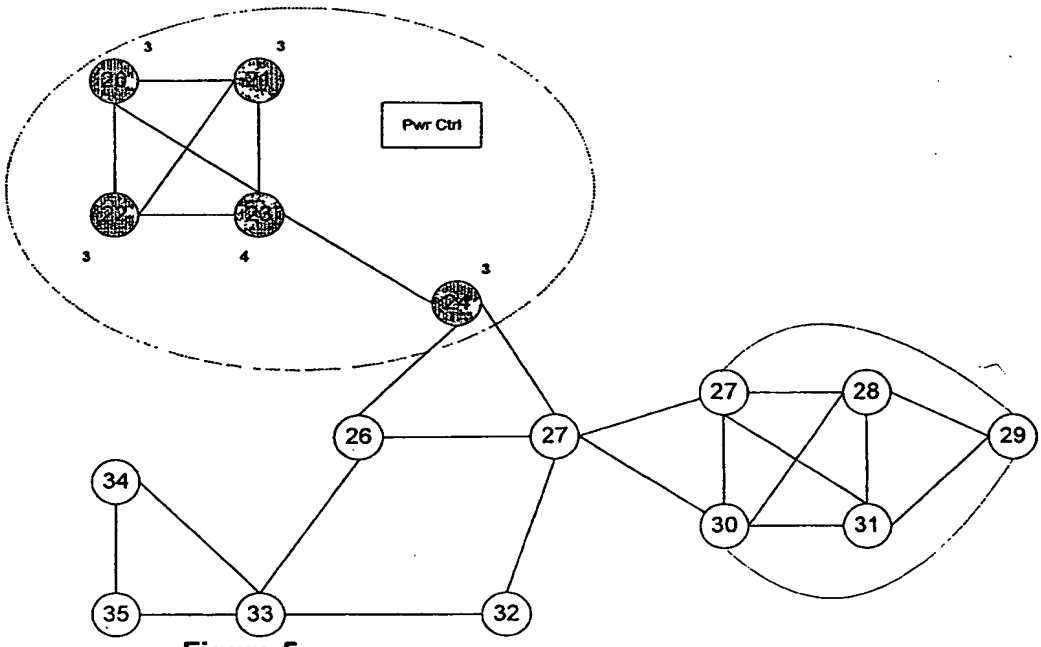

Figure 5

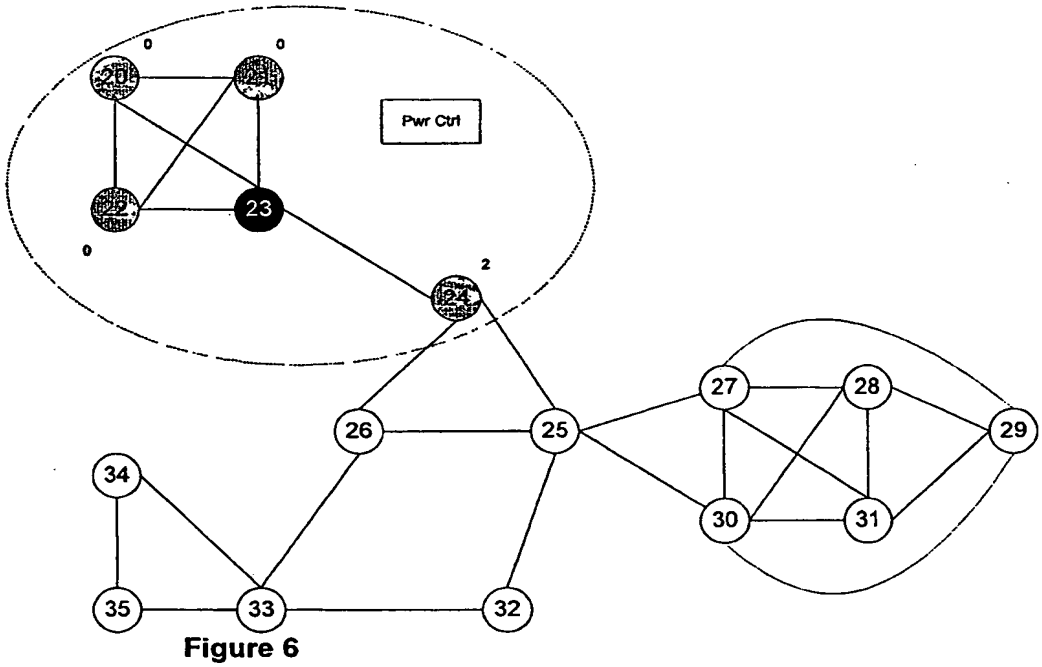

Figure 6

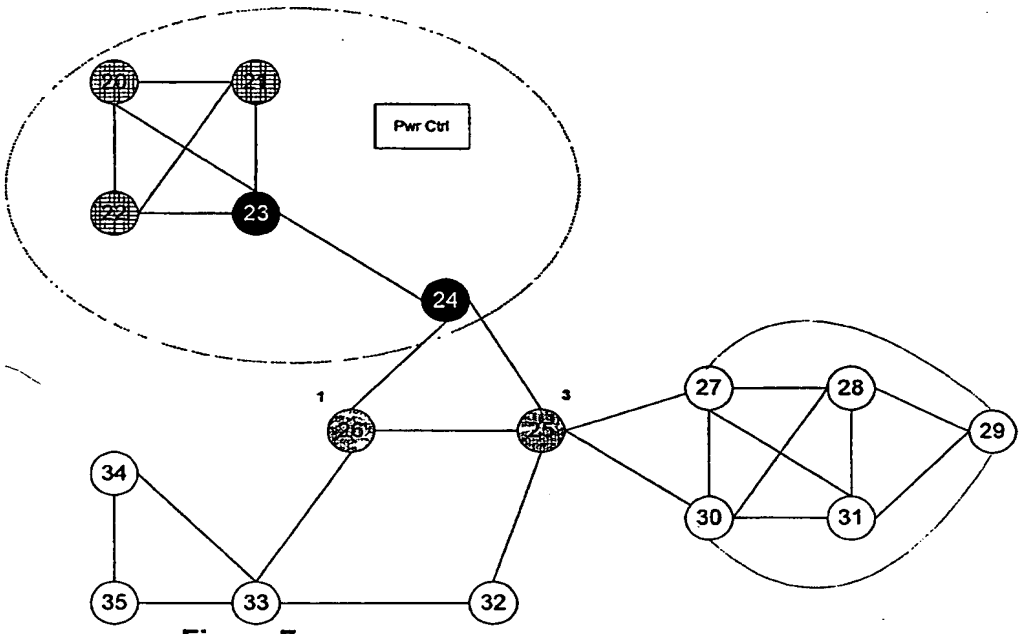

Figure 7

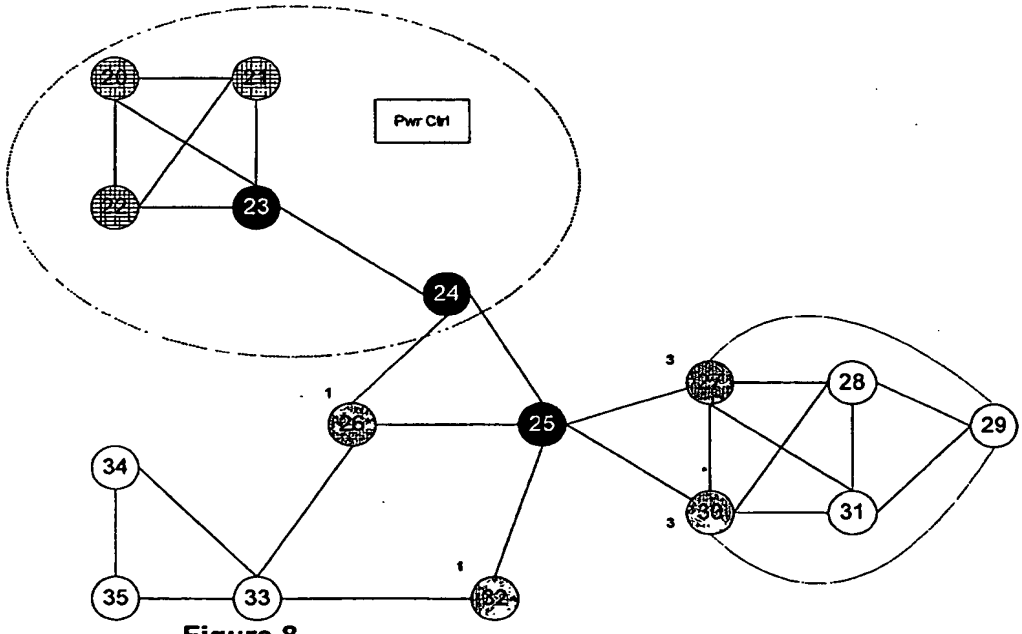

Figure 8

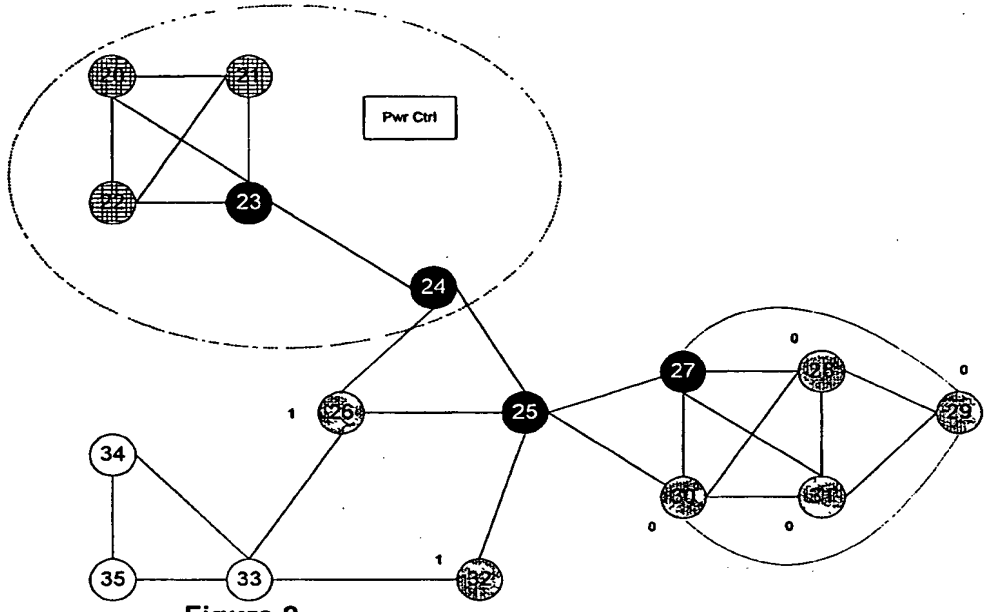

Figure 9

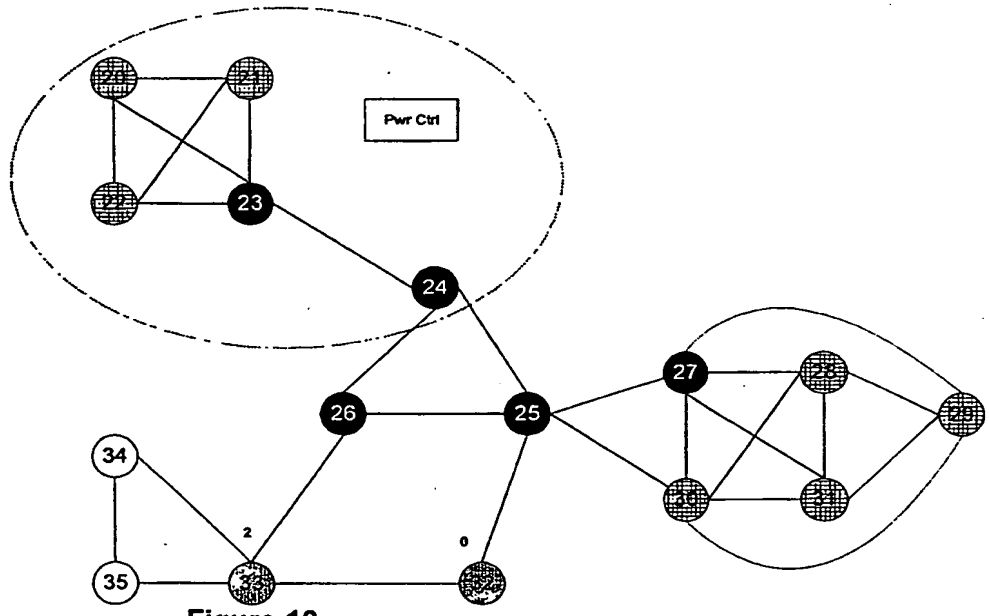

Figure 10

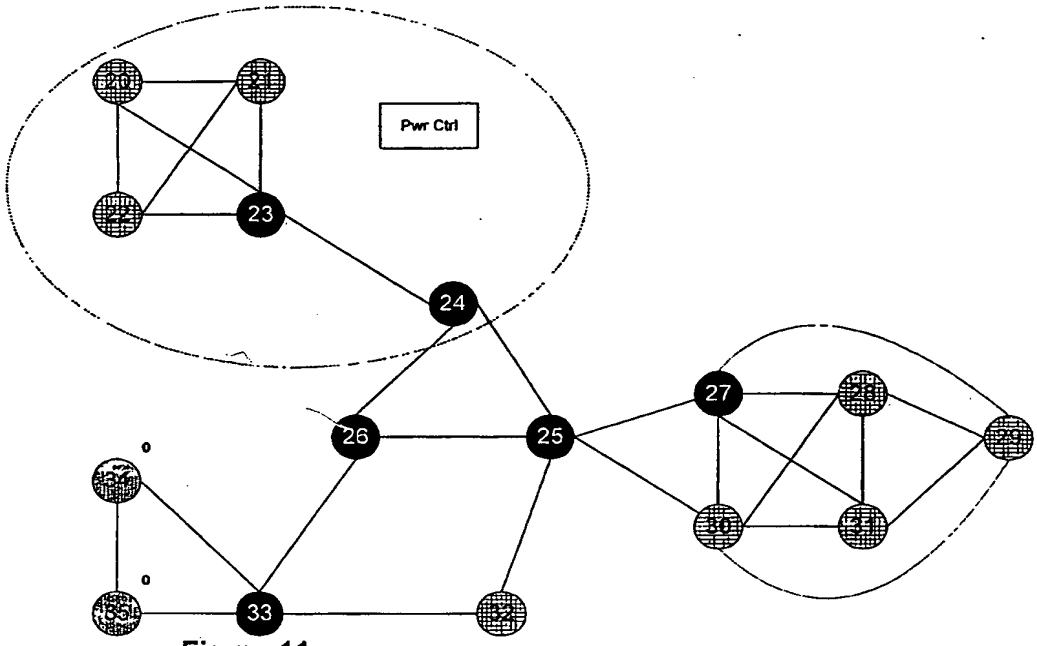

Figure 11

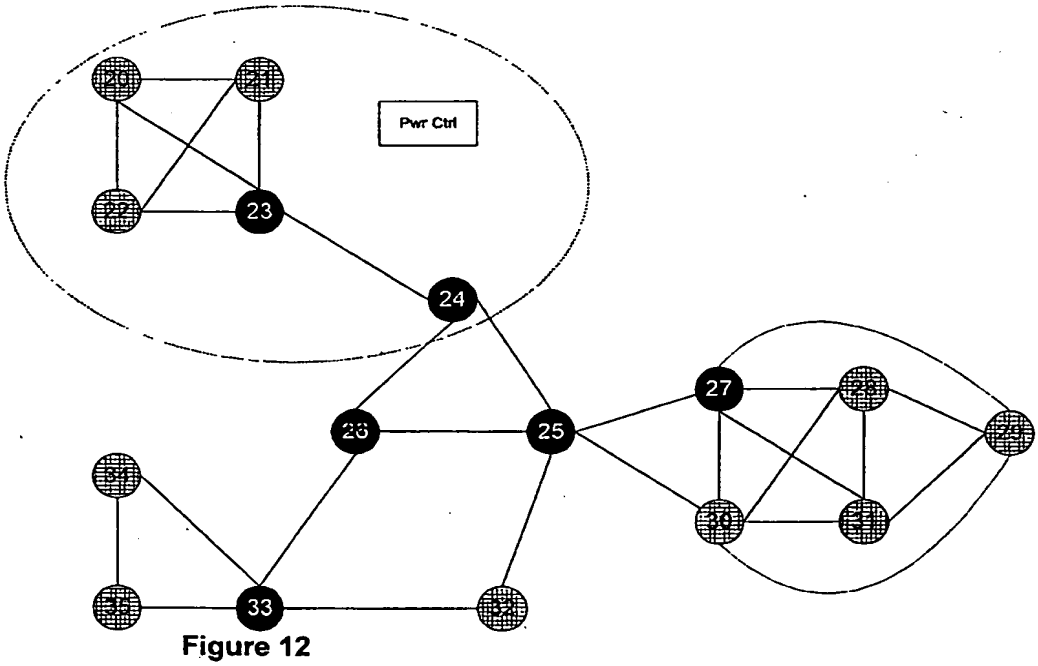

Figure 12

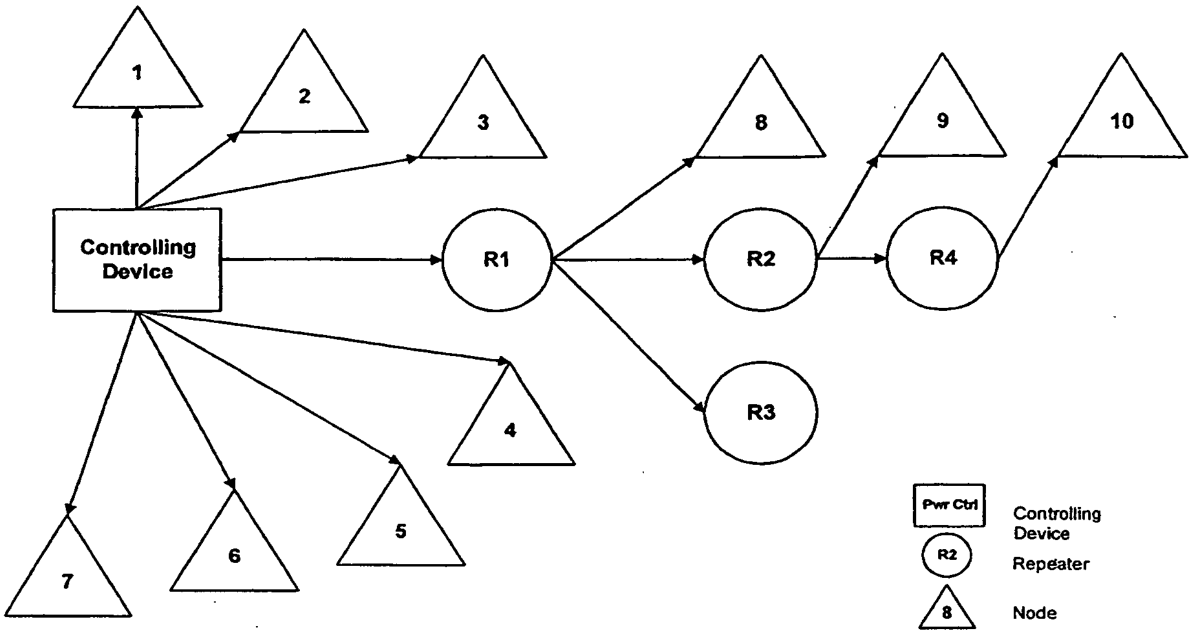

Figure 13

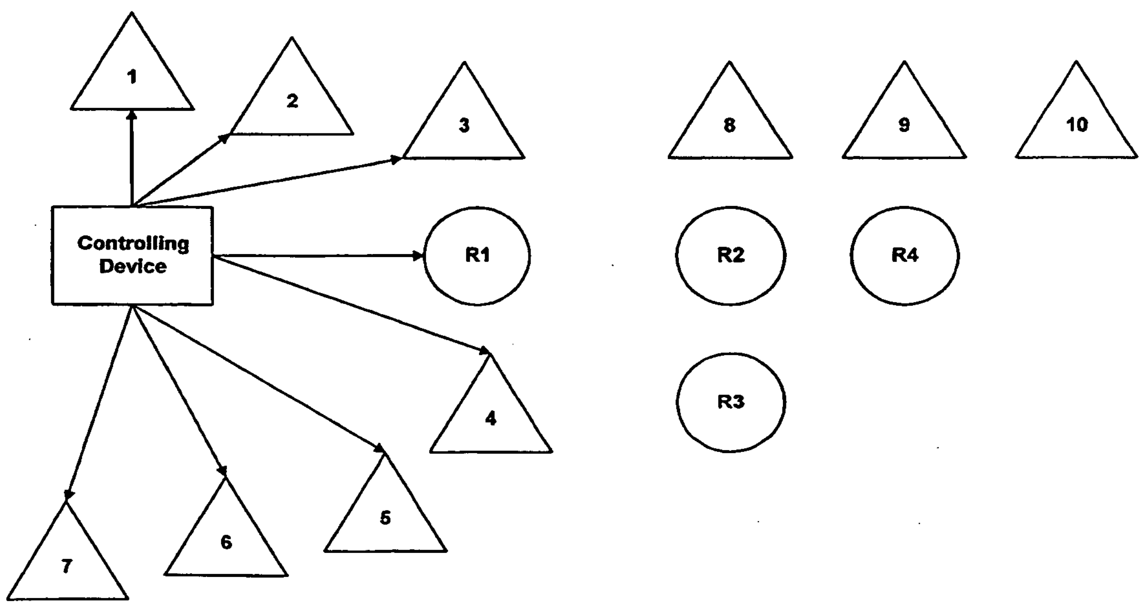

Figure 14

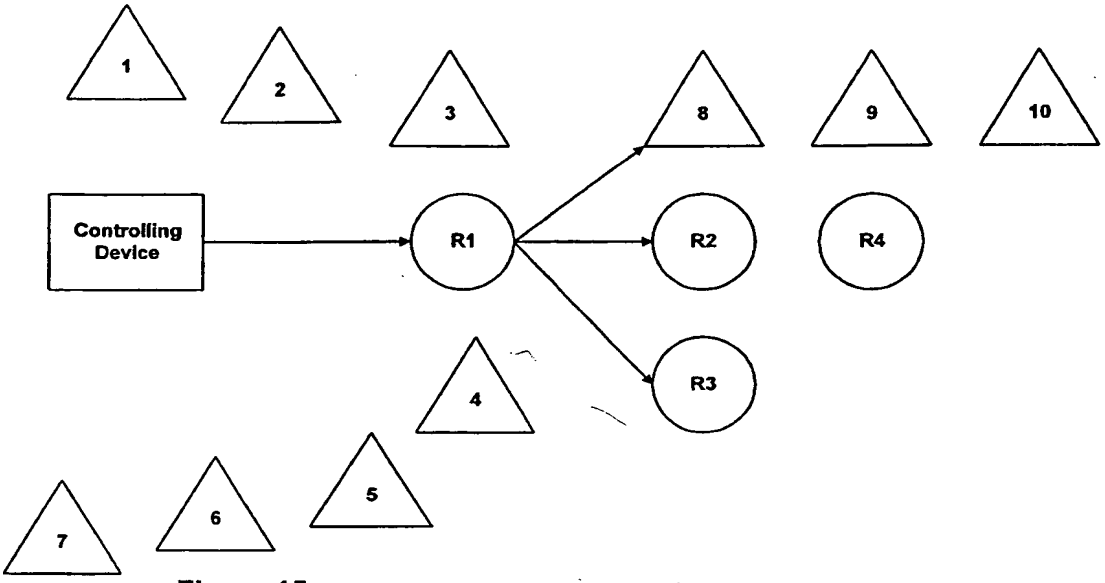

Figure 15

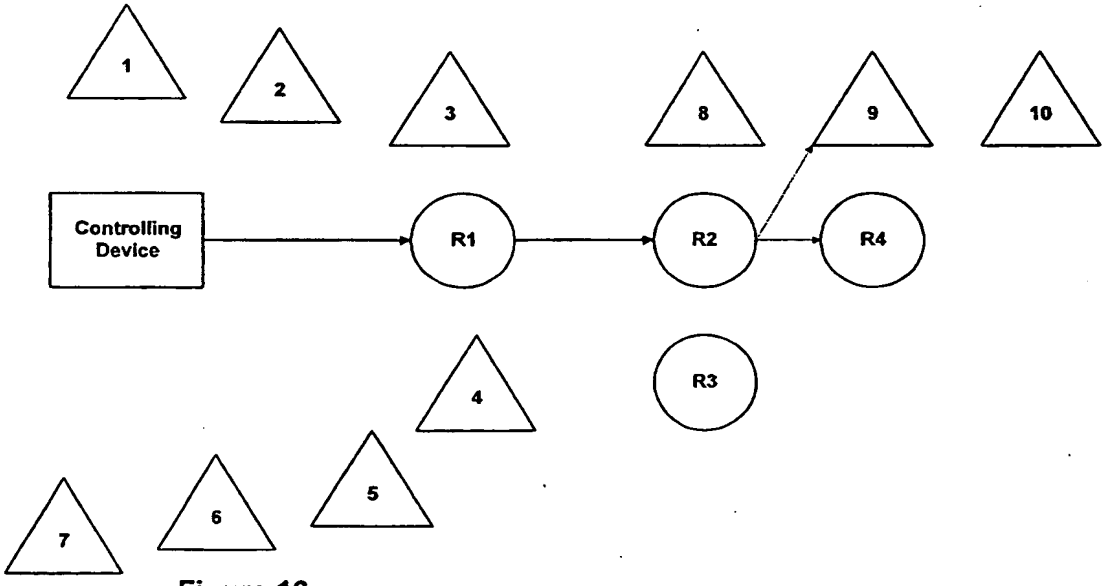

Figure 16

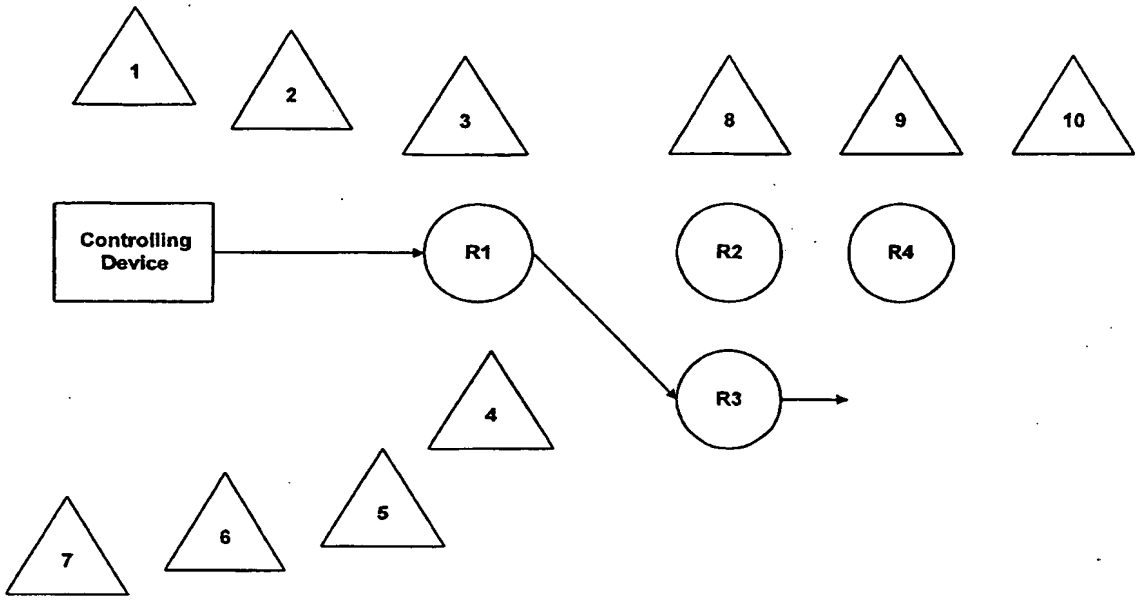

Figure 17

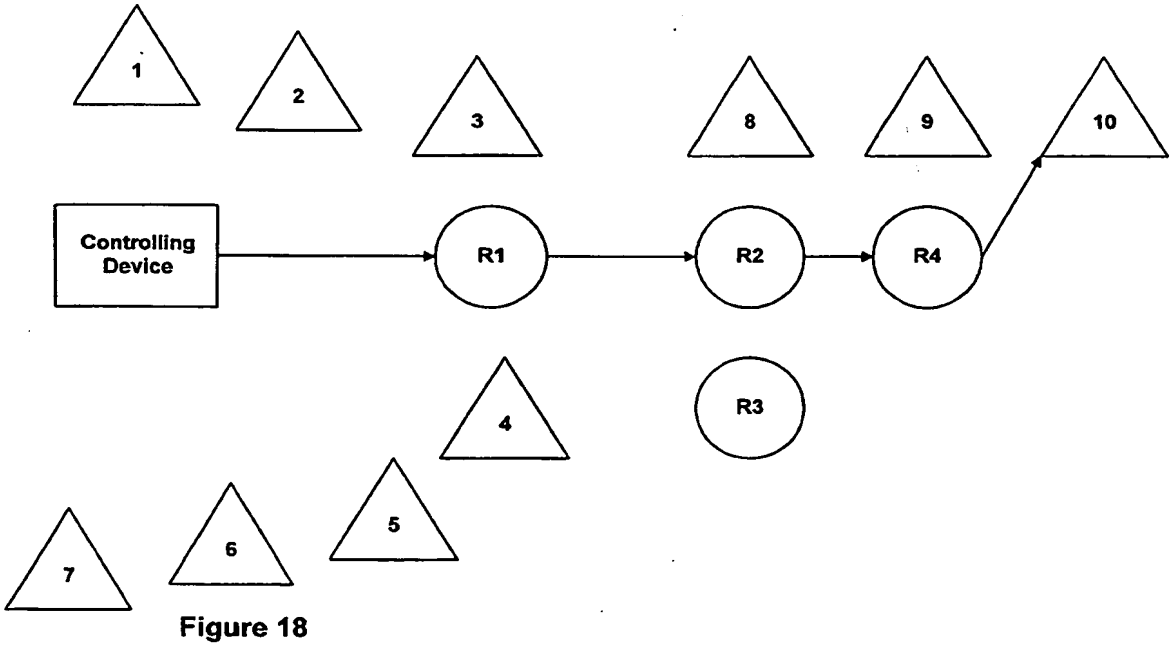

Figure 18

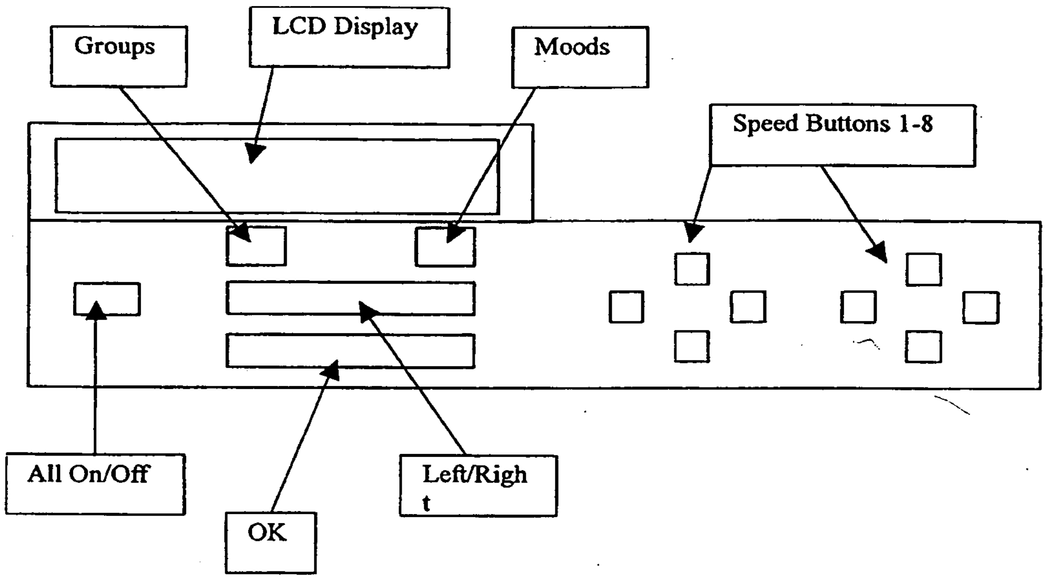

Figure 19

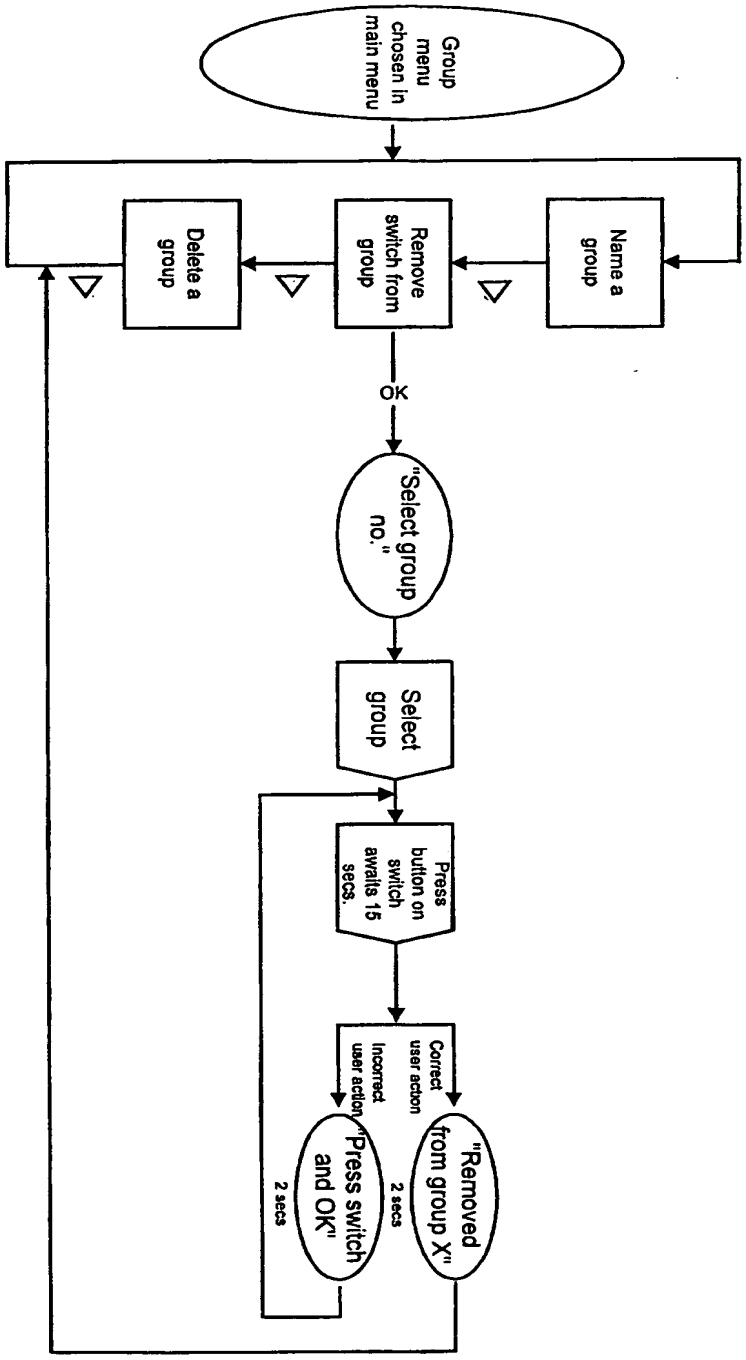
Group menu chosen in main menu
Name a group
Remove switch from group
Delete a group
OK
"Select group no."
Select group
Press button on switch awaits 15 secs.
Correct user action
Incorrect user action
"Removed from group X"
2 secs
"Press switch and OK"
2 secs

Figure 20

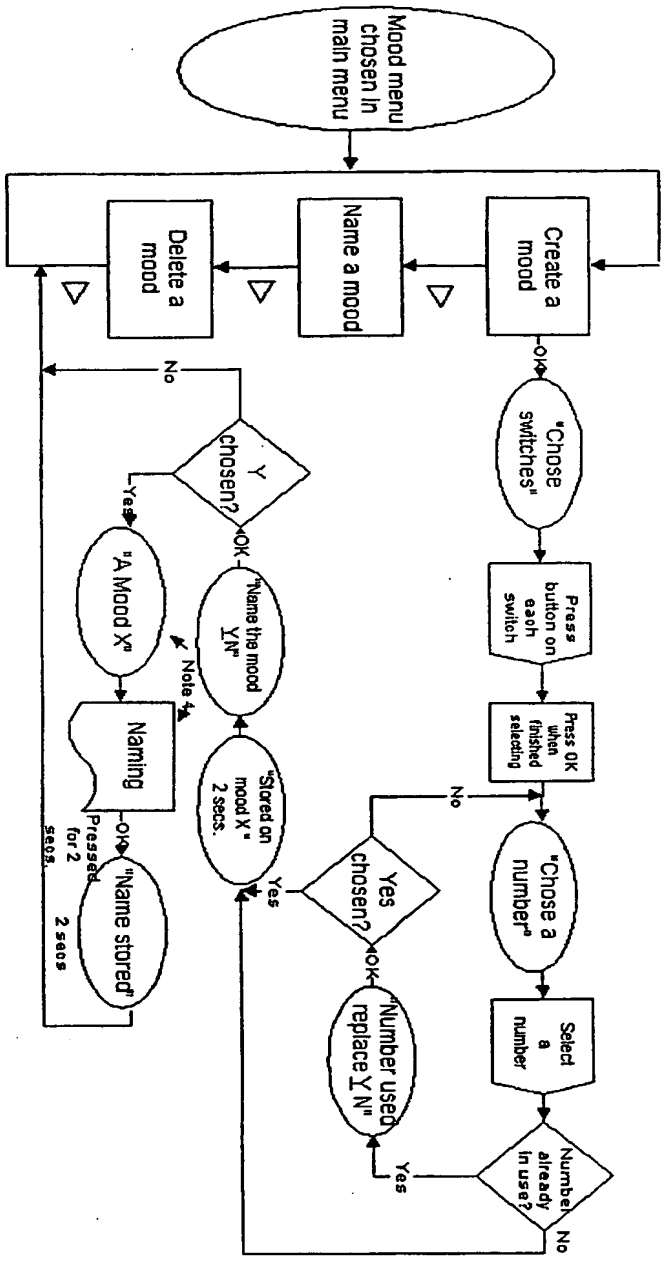

Figure 21

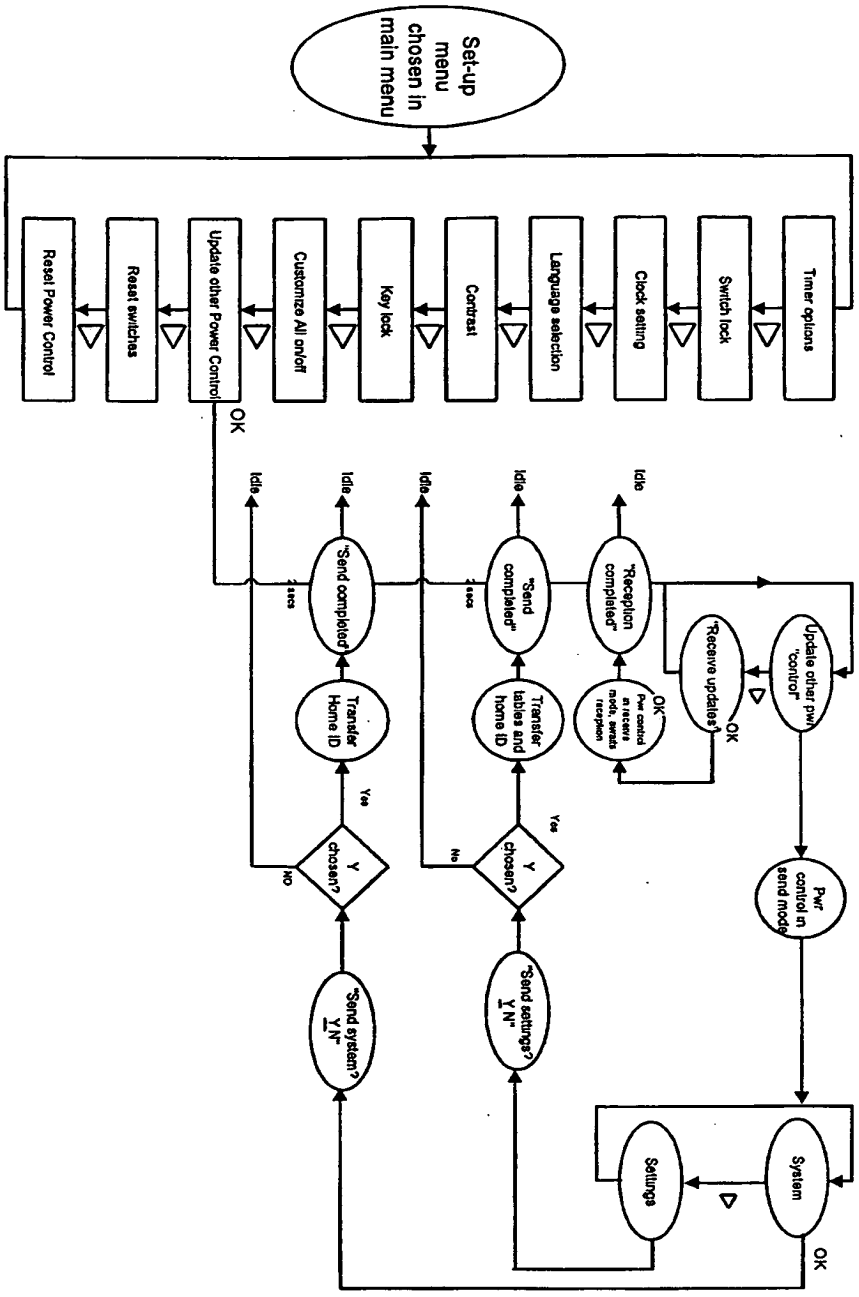
Set-up menu chosen in main menu
Timer options
Switch lock
Clock setting
Language selection
Contrast
Key lock
Customize All on/off
Update other Power Control
Reset switches
Reset Power Control
OK
Idle
"Reception completed"
"Receive updates?"
OK
Update other pwr "control"
Pwr control in receiv mode, awaits reception
OK
"Send completed"
2 secs
Transfer tables and home ID
Y chosen?
Yes
No
"Send settings? Y N"
"Send completed"
2 secs
Transfer Home ID
Y chosen?
Yes
NO
"Send system? Y N"
Pwr control in send mode
System
Settings
OK

Figure 22

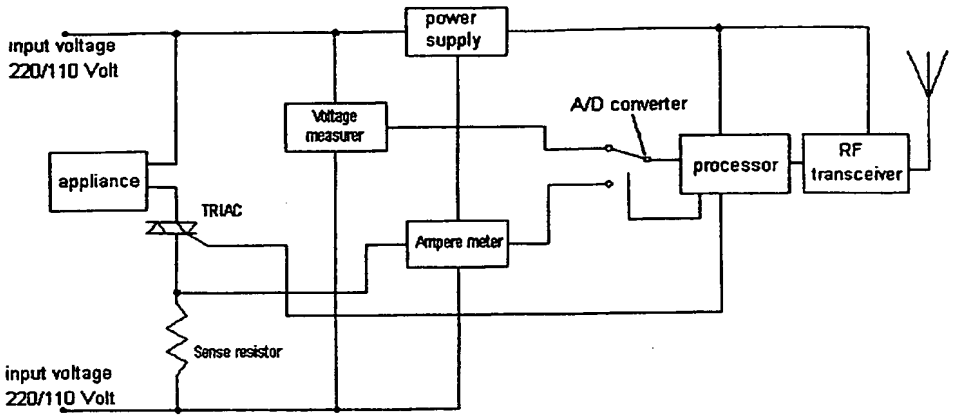

Figure 23

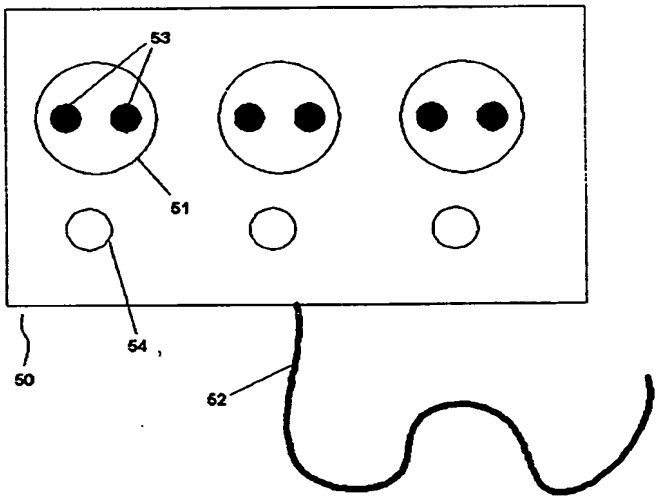

Figure 24